LITTLE BOW RIVER BASIN

Economic & Financial Analysis of Irrigation Development

MARV ANDERSON & ASSOCIATES LTD.
ECONOMIC CONSULTANTS

LITTLE BOW RIVER BASIN

ECONOMIC AND FINANCIAL ANALYSIS OF IRRIGATION DEVELOPMENT

ALBERTA ENVIRONMENT

PLANNING DIVISION

April 1986

MARV ANDERSON & ASSOCIATES LIMITED
ECONOMIC CONSULTANTS

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April 30, 1986

Mr. D. H. Younie,
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Edmonton, Alberta. T5K 2J6

Dear Mr. Younie:

It is a pleasure to submit to you our final report entitled: *Little Bow River Basin: Economic and Financial Analysis of Irrigation Development*, in accordance with Contract No. 86-0596.

As requested, this document is an economic and financial analysis of the feasibility of developing additional irrigation in the Little Bow River Basin if one of ten potential on-stream storage sites was constructed.

We believe that the analysis herein should provide Alberta Environment with all the economic input required in the policy-making process.

Thank you for your continued support throughout the duration of this study. We look forward to the possibility of working with you again in the challenging months and years ahead.

Respectfully submitted,

MARV ANDERSON & ASSOCIATES LTD.

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EXECUTIVE SUMMARY

THE OVERALL OBJECTIVE OF THIS STUDY WAS TO DETERMINE THE ECONOMIC AND FINANCIAL FEASIBILITY OF DEVELOPING ADDITIONAL STORAGE TO AUGMENT WATER SUPPLIES FOR IRRIGATED AGRICULTURE IN THE LITTLE BOW RIVER BASIN. TEN POTENTIAL WATER STORAGE OPTIONS WERE CONSIDERED.

THE STUDY FOCUSES EXCLUSIVELY ON THE ANTICIPATED BENEFITS TO AGRICULTURE.

THE BASIC EMPIRICAL RESULTS (ATTACHED) INDICATE THAT THE BENEFIT-COST RATIOS ARE GENERALLY WELL ABOVE UNITY WHILE THE ACCOMPANYING NET PRESENT VALUES ARE GENERALLY POSITIVE. TWO SITES, HOWEVER, APPEAR PARTICULARLY GOOD:

- SITE 7B-1 WITH INCREASED CANAL CAPACITY
- SITE LB1 WITH INCREASED CANAL CAPACITY

SITE 7B-1, BECAUSE OF ITS RELATIVELY LARGER SIZE, HAS THE POTENTIAL TO GENERATE A SLIGHTLY HIGHER NET PRESENT VALUE OVER THE THIRTY YEAR PROJECT PERIOD AND FOR THIS REASON MIGHT BE THE BEST OPTION.

IT APPEARS TO BE PARTICULARLY IMPORTANT THAT EITHER OF THESE DEVELOPMENTS BE ACCOMPANIED BY ADDITIONAL CANAL CAPACITY.

THE ACCOMPANYING SOCIO-ECONOMIC ANALYSIS INDICATES THAT WHEN REGIONAL/PROVINCIAL SPINOFFS FROM MORE INTENSIVE AGRICULTURAL OPERATIONS IN THE BASIN ARE ALSO CONSIDERED, THE PROVINCIAL BENEFIT-COST RATIOS SHOULD ALMOST DOUBLE WHILE THE RESPECTIVE (DIRECT + INDIRECT) NET PRESENT VALUES WOULD PROBABLY BE FOUR OR FIVE TIMES AS LARGE AS THE THE DIRECT NET PRESENT VALUES.

FROM A REGIONAL PERSPECTIVE, SHORT-TERM CONSTRUCTION EXPENDITURES WOULD ALSO BE EXPECTED TO PROVIDE LOCAL COMMUNITIES WITH AN INCOME INJECTION OF BETWEEN $1 M AND $4.2 M OVER A TWO YEAR PERIOD. BUT IN THE LONGER-TERM, THIS WOULD BE DWARFED BY THE SPINOFFS FROM MORE INTENSIVE AGRICULTURAL OPERATIONS AND RELATED ACTIVITY IN THE BASIN.

THE FINANCIAL IMPLICATIONS OF ON-FARM IRRIGATION DEVELOPMENT IN THE BASIN INDICATES THAT FARM PROFITABILITY IS LARGELY DEPENDENT UPON A FARMERS' PARTICULAR RESOURCE BASE, PRODUCT MIX, MANAGEMENT, CAPITAL STRUCTURE, AND LOCATION/ELEVATION FROM THE LITTLE BOW RIVER. NEVERTHELESS, THIS SUPPLEMENTARY ANALYSIS DOES SUGGEST THAT IRRIGATED AGRICULTURE PRESENTLY HAS A COMPARATIVE ADVANTAGE OVER DRYLAND AGRICULTURE IN THE STUDY AREA.

FOR THE PREFERRED SITES, THE EXPECTED RATES-OF-RETURN ARE RELATIVELY GOOD AND COMPARE VERY FAVORABLY WITH OTHER IRRIGATION DEVELOPMENT PROPOSALS IN SOUTHERN ALBERTA, BOTH PAST AND PRESENT. THIS COMPARATIVE ADVANTAGE STEMS FROM THE FACT THAT (A) ONLY DIRECT PUMPING BY LOCAL FARMERS (WITH NO RELATIVELY COSTLY DISTRIBUTION SYSTEM) IS BEING CONSIDERED SUCH THAT UNIT COSTS ARE RELATIVELY LOW, AND (B) THE RELATIVE PAY-OFF TO IRRIGATION IN THIS NANTON-CARMANGAY REGION VIS-A-VIS OTHER REGIONS SHOULD BE RELATIVELY HIGH.

Table 1

ALTERNATIVE STORAGE SITES IN THE LITTLE BOW RIVER BASIN: RESERVOIR CHARACTERISTICS AND ECONOMIC ASSESSMENT

Reservoir Site*	RESERVOIR CHARACTERISTICS			ECONOMIC ASSESSMENT**		
	Capacity (acre feet)	Capital Cost ($M)	Irrigation Potential (acres)	Benefit-Cost Ratio	Net Present Value ($M)	Overall Assessment
1. Site LB1 (100 cfs and 60 cfs)	17,250	8.3	17,400	1.39	7.9	O.K.
2. Site SC2 (100 cfs and 60 cfs)	14,400	8.2	13,700	1.28	5.0	O.K.
3. Site 7A (300 cfs and 60 cfs)	70,000	21.0	43,900	1.10	5.2	Marginal
4. Site 7B-1 (300 cfs and 60 cfs)						
(a) low	30,000	9.5	33,900	1.47	15.0	Good
(b) intermediate	50,000	11.4	40,400	1.39	14.8	Good
(c) high	70,000	13.8	43,900	1.31	13.2	Good
5. Site LB1 plus Site SC2 (100 cfs and 60 cfs)	31,650	15.7	19,900	1.05	1.4	Marginal
6. Site LB1 (300 cfs and 60 cfs)	17,250	8.5	26,400	1.49	13.0	Good
7. Site SC2 (100 cfs and 120 cfs)	14,400	8.9	19,700	1.39	9.8	O.K.
8. Site 7B-1 plus Site LB1 plus Site SC2 (300 cfs and 60 cfs)	101,650	28.8	45,200	0.95	(3.1)	Not Feasible

*Bracketed figures are capacities for the Little Bow Canal and Squaw Coulee Canal respectively.

**Total costs versus the net benefits to agriculture, ie. ignores possible net benefits to non-agriculture.

ACKNOWLEDGEMENTS

Numerous people have contributed greatly to the successful completion of this study.

In particular, the authors would like to thank three local farmers for their assistance in the preparation of the farm budgets utilized in this analysis: Mr. Gary Flitton, Mr. Gerald Alder, and Mr. Ralph Walker.

Personnel in Alberta Environment were also very supportive throughout the preparation of this report. These people include, in particular: Mr. Doug Younie (Edmonton), and Mr. Lorand Szojka, Mr. Sandy Larsen, Mr. John Carlson, and Ms. Wendy Procyshen (Lethbridge).

In the final analysis, however, all errors or omission which remain are the responsibility of the authors.

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1. INTRODUCTION

1.1 Background

As shown in Figure 1.1 the Little Bow River Basin forms a part of the Oldman River watershed and is located south and east of the Town of High River. The Basin borders on the Highwood River Basin to the Northwest, Willow Creek Basin to the Southwest, Highway No. 520 to the South, Arrowwood Creek to the North and McGregor Lake and Travers Reservoirs to the East. The total catchment area for the Basin including its major tributary (Mosquito Creek) is about 2,200 square miles (5,600 km^2).

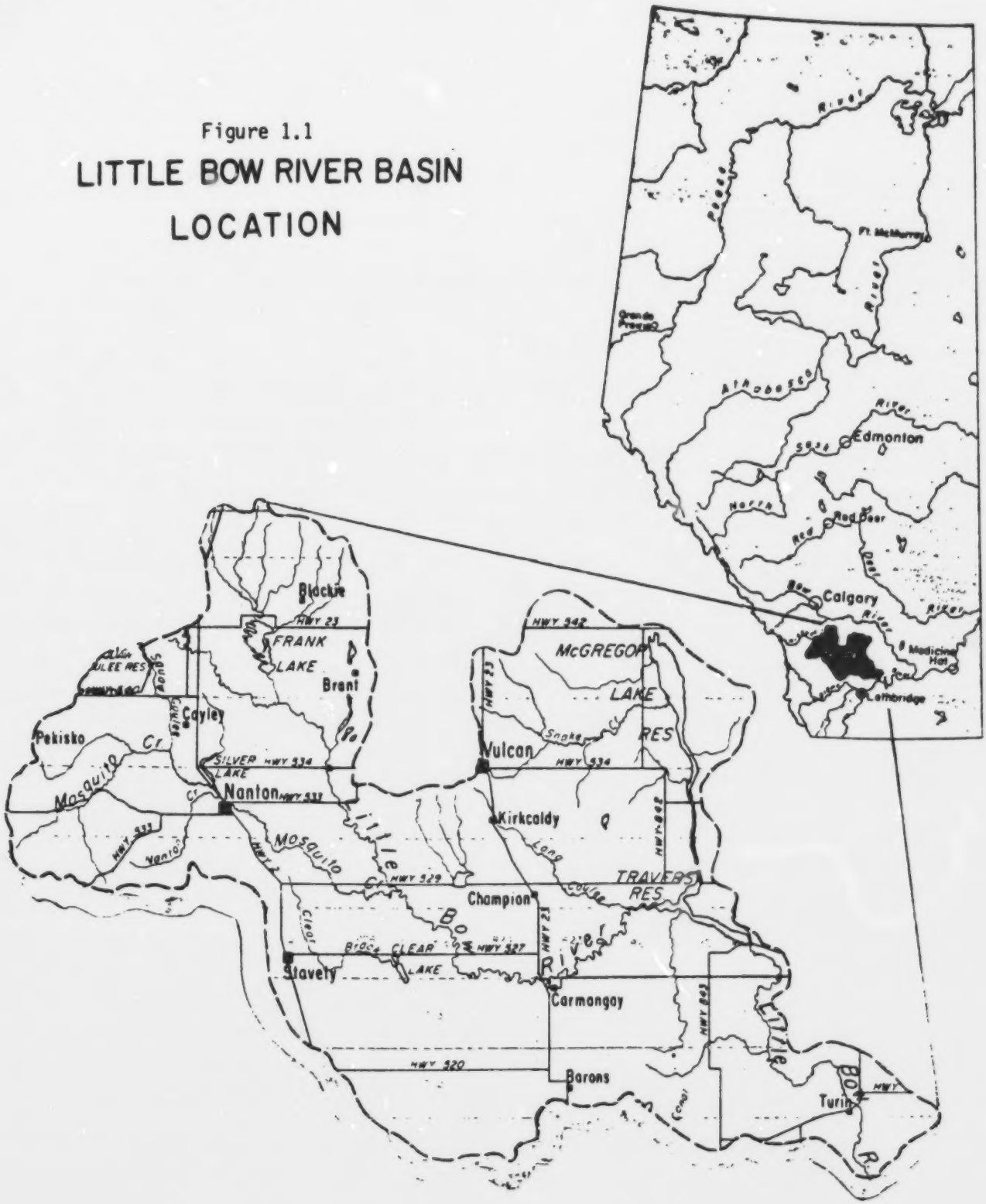
The land is largely cultivated agriculture devoted to cereal grains but contains some non-arable areas in native grass. In a year of adequate precipitation the Basin is one of the top wheat producing areas in Southern Alberta. Ranching is characteristic of the very eastern portion of the Basin and there are also numerous feedlots and other livestock and poultry operations throughout the region.

The largest communities within the Basin are Nanton and Vulcan while High River and Claresholm lie just outside the Basin. All four communities have diverse commercial activities but agricultural service industries predominate.

The Little Bow River along with its tributaries and diversions from the nearby Highwood River represents the major source of water supply for domestic, municipal, agricultural and industrial requirements within the Basin. The Town of Carmangay depends upon Little Bow River for its water supply as do the many farmsteads located within the Basin. But steadily increasing water demands, combined with recent drought, within the Little Bow River Basin in recent years have resulted in acute supply-demand imbalances during the growing season.

Figure 1.1

LITTLE BOW RIVER BASIN
LOCATION



Drawing courtesy PFRA

This imbalance became increasingly acute during the late 1970's and early 1980's (generally very dry years) when streamflows dropped but water demands steadily climbed, particularly in the agricultural sector which is by far the largest water user in the Basin. (Figure 1.2) A crisis was only averted during this period by placing a moratorium on all new water project proposals (excluding domestic and municipal) during 1977/78 and, again, after October 1983.

To deal effectively with this problem, Alberta Environment initiated a multi-phase Little Bow River Basin Planning Study in 1982. These studies first identified existing water supply and management problems in the Basin (Phase I) and then proposed and evaluated alternative water management options for the region (Phase II) The Phase II storage site studies are now nearing completion.

1.2 Present Study Objectives

As one of a number of Phase II studies, the overall objective of this particular study is to determine the *economic* and *financial* feasibility of developing on-stream storage sites and canal sizing options to augment water supplies in the Little Bow River Basin.

The ten alternatives to be considered are: [1]

1. Site LB1 (100 cfs and 60 cfs)
2. Site SC2 (100 cfs and 60 cfs)
3. Site 7A (300 cfs and 60 cfs)
4. Site 7B-1 (300 cfs and 60 cfs)
   (a) low
   (b) intermediate
   (c) high
5. Site LB1 plus Site SC2 (100 cfs and 60 cfs)
6. Site LB1 (300 cfs and 60 cfs)
7. Site SC2 (100 cfs and 120 cfs)
8. Site 7B-1 plus LB1 plus SC2 (300 cfs and 60 cfs)

Further details are provided in Section 2.2 following. The specific Terms of Reference are also attached in accompanying Appendix A.

1.3 Study Methodology

The study focuses exclusively on the anticipated benefits and costs to agriculture.

The basic methodology is discounted cash flow analysis, a methodology which traces all the tangible incremental costs and benefits of a project over time, adjusts future dollars to the present by employing a discount rate, and then compares the cumulative value of the projected benefit stream with the cumulative value of the

---

[1] Bracketed figures are capacities for the Little Bow Canal and Squaw Coulee Canal respectively.

anticipated cost stream. Thus:

$$B/C = \frac{\text{Sum of Discounted Tangible Incremental Benefits}}{\text{Sum of Discounted Tangible Incremental Costs}}$$

NPV = Sum of Discounted Tangible Incremental Benefits
minus Sum of Discounted Tangible Incremental Costs

To be economically or financially feasible, the Benefit-Cost Ratio (B/C) must exceed 1.0, and the Net Present Value (NPV) must be positive.

This assessment is conducted from three different perspectives (accounting stances): farmers, the region, and the province.

1.4 Study Outline

The following study adheres closely to the study objectives and the logic underlying the study methodology:

Section 2 - Cost Estimates

Section 3 - Net Benefit Estimates

Section 4 - Economic Analysis

Section 5 - Farm Financial Analysis

Section 6 - Summary and Conclusions

Background agricultural cost and production data, the basic economic benefit-cost simulations, and a brief statistical profile of agricultural producers in County #2 (Vulcan) are also appended.

2. COST ESTIMATES

2.1 Introduction

The purpose of this section is to summarize all of the estimated incremental capital and operating costs associated with the various water storage/delivery alternatives. These include: (a) reservoir costs; (b) delivery system costs; and (c) on-farm sprinkler system costs. Incremental on-farm production costs and indirect non-farm costs are considered in Section 3 following.

2.2 Reservoir Costs

Estimated capital costs (in 1985 dollars) for the various reservoirs are summarized in accompanying Table 2.1. (Also see Figure 2.1.)

These expenditures are expected to arise over a two year construction period; 40 percent of the total costs in the first year and 60 percent in the second year.

In addition, and regardless of the reservoir constructed, annual operating and maintenance costs associated with the reservoir/canal are estimated to amount to about two (2) percent of the respective initial capital costs per annum.

2.3 Delivery System Costs

All anticipated irrigation development in the Little Bow River Basin would be contiguous to the various rivers, creeks, and lakes.

Table 2.1

ESTIMATED CAPITAL COSTS FOR ALTERNATIVE STORAGE SITES
LITTLE BOW RIVER BASIN
($ 1985)

Proposed Reservoir Site*	Reservoir Capacity (acre feet)	Capital Cost Estimates**		
		Reservoir	Related Canal	Total
1. Site LBI (100 cfs and 60 cfs)	17,250	7,525,000	750,000	8,275,000
2. Site SC2 (100 cfs and 60 cfs)	14,400	7,444,000	750,000	8,194,000
3. Site 7A (300 cfs and 60 cfs)	70,000	20,032,000	950,000	20,982,000
4. Site 7B-1 (300 cfs and 60 cfs)				
(a) low	30,000	8,596,000	950,000	9,546,000
(b) intermediate	50,000	10,498,000	950,000	11,448,000
(c) high	70,000	12,831,000	950,000	13,781,000
5. Site LBI plus SC2 (100 cfs & 60 cfs)	31,650	14,969,000	750,000	15,719,000
6. Site LBI (300 cfs and 60 cfs)	17,250	7,525,000	950,000	8,475,000
7. Site SC2 (100 cfs and 120 cfs)	14,400	7,444,000	1,500,000***	8,944,000
8. Site 7B-1 plus Site LBI plus SC2 (300 cfs and 60 cfs)	101,650	27,800,000	950,000	28,750,000

*Bracketed figures are capacities for the Little Bow Canal and Squaw Coulee Canal respectively. The existing capacity of the Little Bow Canal is 100 cfs; the present design capacity of the Squaw Coulee Canal is 60 cfs.

**Includes engineering, structural construction, land, related costs (utility and relocations) and contingencies. Excludes building relocation or purchase.

***Assumed cost.

Sources: (1) WER Engineering, *Little Bow River Basin Storage Site Investigation - Feasibility Design Report*, Alberta Environment, Calgary, June 1985.
(2) WER Engineering, *Little Bow River Basin Storage Site Investigation - Confluence Site (7B-1) - Feasibility Design Report*, Alberta Environment, Calgary, September 1985.
(3) PFRA, *Little Bow River Basin Study - Engineering Report*, Calgary, April 1985.
(4) WER Engineering, *Little Bow River Basin Storage Site Investigation- Site (7A)- Feasibility Design Report*, Alberta Environment, Calgary, March 1986.

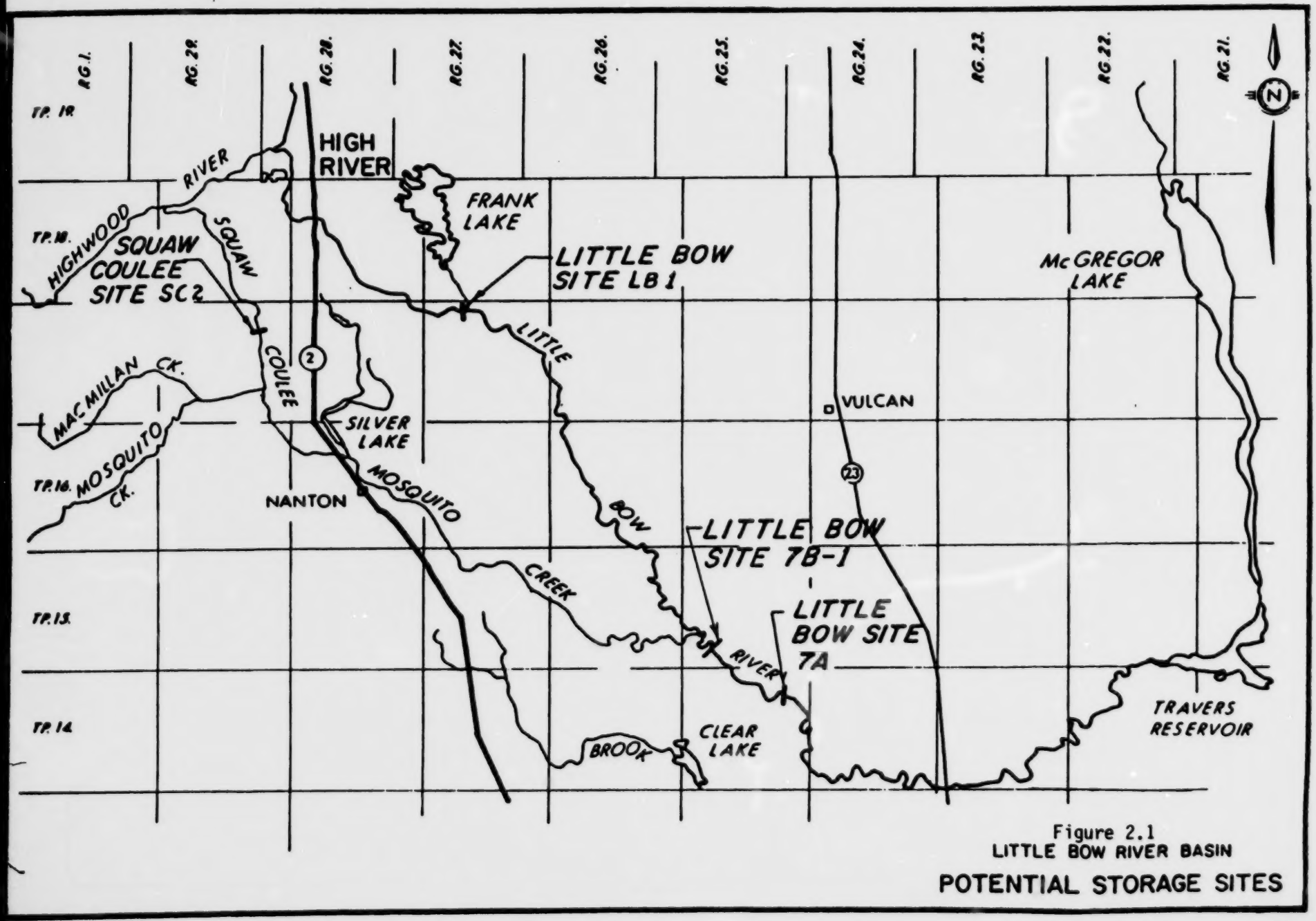


Figure 2.1
LITTLE BOW RIVER BASIN
POTENTIAL STORAGE SITES

For all private pumping schemes, farmers would pump directly from the river via buried pipe. This would be installed by the farmer and paid for by the farmer. The maintenance costs associated with this system would be negligable. Nor would there be any off-farm operating costs which are characteristic of most off-farm systems, such as annual Irrigation District costs which are required for operation, maintenance, and rehabilitation of distribution works.

Initial capital costs for these systems are dependent on how far the water must be piped and how the on-farm system is designed. A one-half mile system is illustrated in Figure 2.2. We estimate that in general the distances and costs indicated in Table 2.2 following reflect what farmers would probably have to pay (in 1985 dollars) to install delivery systems from the river to their irrigated parcel.

Assuming the closest land was developed first, the weighted average cost would vary, depending upon how much additional irrigation was actually developed. The greater the area irrigated, the higher the average cost.

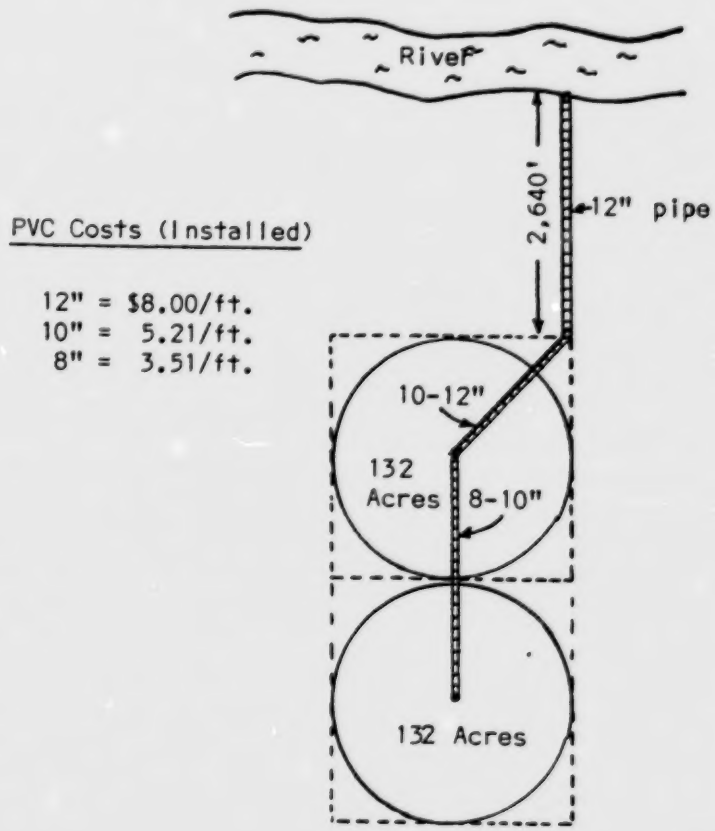
2.4 Sprinkler System Costs

On-farm irrigation systems are expected to generally be center pivots, either new or used. Sprinkler systems can be installed for approximately $60,000 per unit, as suggested following:

Center Pivot (new)	$35,000
Water lines/drops	7,000
Powerline/rotophase	5,500
Natural gas installation	2,000
Pump and motor	10,000
TOTAL	$59,500

Figure 2.2

A TYPICAL ONE-HALF MILE DELIVERY SYSTEM
SERVING TWO CENTER PIVOTS



PVC Costs (Installed)

12" = $8.00/ft.
10" = 5.21/ft.
8" = 3.51/ft.

Table 2.2

DELIVERY SYSTEM COSTS AND RELATED ACREAGES

Distance	Average Lift[a]	Acreage			Cost/Acre
		Total[b]	Existing[c]	Additional	
Adjacent	50'	7,425	3,600	3,825	-
½ mile	100'	19,170	9,500	9,670	$80[d]
1 mile	100'	6,615	-	6,615	$131[d]
	200'	10,000	-	10,000	$200[e] } $172
1½ miles	200'	20,790	-	20,790	$300[e]
		64,000	13,100	50,900	

[a] Estimated from: Alberta Agriculture/Project Planning Branch, *Irrigation Feasibility in the Little Bow Basin*, Lethbridge, November 1985.

[b] The first three acreages represent Option A, i.e., 33,210 acres, as per Alberta Agriculture, *op. cit.* The remaining acreages are based on estimates by local farmers and by Alberta Environment personnel.

[c] Assumes the existing irrigated acreage of 13,100 acres is on about 1/2 of the adjacent and one-half of the 1/2 mile potential. Reconciled after consultation with local farmers, visual inspection of the area, and information in WER, *Little Bow Basin Irrigation Water Use Study, 1982 and 1983*, Alberta Environment/Planning Division, Lethbridge, June 1984.

[d] Based on 132 acres per center pivot. Estimated in consultation with local farmers. (Also see Figure 2.2.)

[e] Authors estimates considering the scenarios in Alberta Agriculture, *op. cit.*, and related studies for the Clear Lake-Willow Creek Basin areas. (This is an upper limit since the actual lift for this particular land class may not be this high.)

For 132 acres, this amounts to about $450/acre. However, as Table 2.3 suggests, total capital costs are very dependent on exactly what kind of a system is actually installed. In addition, the farmer can either purchase a new or used system and be more or less involved in the actual installation.

It is, therefore, estimated that the actual capital cost of an on-farm irrigation system in the Little Bow area would likely only *average* about $50,000 per unit, or say $380 per acre.

In addition, related operating and maintenance costs depend on how far the center pivot is from the water source and what lift is involved:[1] ($/acre/year)

Distance	Lift		
	50'	100'	200'
Adjacent	24	28	37
½ mile	27	29	39
1 mile	28	31	41
1½ miles	30	32	42

Out of these annual totals, about $4.00/year would be required for equipment maintenance while the remainder would consist of annual expenditures on fuel and electricity.

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[1] This is for a ¼ mile pivot on a ¼ section. See: Alberta Agriculture/ Project Planning Branch, *Irrigation Feasibility in the Little Bow Basin*, Lethbridge, November 1985.

Table 2. 3

COST ESTIMATES FOR ALTERNATIVE ON-FARM IRRIGATION SYSTEMS

SYSTEMS	TOTAL CAPITAL COST PER ACRE*	DOLLARS PER IRRIGATED ACRE PER YEAR						
		COST OF LABOR*	MAINTENANCE AND REPAIRS*	FUEL COSTS BY ENERGY TYPE				
				Electricity A	Electricity B	N. Gas	Diesel	LPG
WHEEL-ROLL (2 laterals per ¼ section, 8 hr. sets)	240	6.79	2.48	19.16	15.39	10.34	27.76	28.34
WHEEL-ROLL (4 laterals per ¼ section, 12 hr. sets)	363	6.30	4.78	21.88	15.15	9.83	26.34	26.88
STATIONARY CENTER Pivot (¼ mi. long)								
A) 70 psi @ pivot	502	2.12	7.32	23.15	16.98	11.22	29.96	30.58
B) 45 psi @ pivot	474	2.12	7.17	16.63	12.19	8.23	21.52	21.97
STATIONARY PIVOT (85 psi ¼ mi. long)	379	0.90	4.64	24.86	18.77	11.98	33.37	34.06
TOWABLE CENTER PIVOT (¼ mi. long)								
A) 70 psi @ pivot	336	3.60	4.76	21.06	17.09	11.25	30.90	31.54
B) 50 psi @ pivot	298	3.60	4.64	15.35	12.45	8.28	22.52	22.99
HARD-HOSE TRAVELER (Reel Irrigator)	473	4.23	5.22	35.01	27.51	17.99	49.38	50.41
BORDER DYKES	359	7.21	2.49	-	-	-	-	-
GATED PIPE (Gravity)	482	6.31	3.61	-	-	-	-	-
GATED PIPE (Pump @ 10 psi)	488	8.10	3.70	3.25	2.21	1.85	3.81	3.89

ASSUMPTIONS:

Water available at the edge of field
12" net water applied per year
160 acres irrigated by wheel rolls and surface methods
132 acres irrigated by 1/4 mile pivot
500 acres irrigated by 1/2 mile pivot
Cost of installing electric or natural gas line not included
Annual water rates ($10-15 per acre) not included

UNIT COSTS: **

Natural gas (GJ)	2.70
Propane (L)	0.24
Diesel (L)	0.41
Labor ($/hr)	6.00

*Averages for all fuel types.
**Rebates included in final calculations.

Source: Alberta Agriculture/Irrigation Division, Lethbridge, 1986.

Assuming that the closest land is developed first, these estimates would again suggest that the larger the area developed, the more likely average region-wide operating and maintenance costs would rise.

Operating and maintenance costs would also commence in Year 3, climbing annually until the land is fully developed.

3. NET BENEFIT ESTIMATES

3.1 Introduction

The expected net benefits of irrigation are here considered with respect to: (a) crop production; (b) livestock production; (c) other direct benefits; and (d) indirect benefits.

3.2 Crop Production

The net income of farm operators from farm production is a mixture of rent from the use of land, labor income from self-employment, property income from the buildings and machinery, and a return to entrepreneurship and risk-taking. This is approximated here by calculating the average net value added for regional crop production, with and without irrigation, and then estimating the net difference. That is:

	Revenue	Costs	Difference
With Project (Irrigation)	R	C	I
Without Project (Dryland)	R'	C'	I'
	R"	C"	I"

where R, C and I are gross revenue, costs, and income (or value-added) respectively.

Irrigation

Hydrology simulations[1] indicate that the proposed reservoirs would allow for additional irrigation of between 15,000 and 50,000 acres, depending upon the water management option selected. The respective acreages are indicated in Table 3.1.

For the economic simulations which follow, it is further assumed that this potential irrigation would be developed at the rate of about 3,500 acres per year, beginning when construction of the reservoir was initiated, i.e. Year 1. This anticipated rate of development is generally consistent with annual increases in the licensed irrigation allocation during 1981-84 (Figure 3.1) and local farmer expectations.

In every case the total potential acreage irrigable is constrained by the available water supply; not potentially irrigable land. Earlier studies by MONECO[2] and Pedology Consultants[3], which encompassed about 150,000 acres in the region, estimated that there are more than 120,000 acres of potentially irrigable land located within three miles of an existing or potential water source within the Basin; far more than could be serviced by any of the water management options here considered.

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[1] Nanuk Engineering, *Little Bow River Basin Phase II Planning Activities, Analyysis of Water Supply Alternatives*, Alberta Environment/Planning Division, Lethbridge, May 1986.

[2] MONECO Consultants Limited, *Carmangay and East of Parkland Land Irrigability Classification*, Alberta Environment, Calgary, January 1983.

[3] Pedology Consultants, *Irrigability Classification Level II of Clear Lake*, Alberta Environment, Calgary, 1984.

Table 3.1

ADDITIONAL POTENTIAL IRRIGATION IN THE LITTLE BOW RIVER BASIN
FOR ALTERNATIVE RESERVOIR DEVELOPMENT PROPOSALS

Proposed Reservoir Site *	Total Potential Irrigation **(acres)			Additional Potential Irrigation***(acres)		
	Above Confl. Reach 2-3	Below Confl. Reach 1	TOTAL	Above Confl. Reach 2-3	Below Confl. Reach 1	TOTAL
1. Site LBI (100 cfs and 60 cfs)	14,000	16,500	30,500	9,200	8,200	17,400
2. Site SC2 (100 cfs and 60 cfs)	12,800	14,000	26,800	8,000	5,700	13,700
3. Site 7A (300 cfs and 60 cfs)	15,500	41,500	57,000	10,700	33,200	43,900
4. Site 7B-1 (300 cfs and 60 cfs)						
(a) low	15,500	31,500	47,000	10,700	23,200	33,900
(b) intermediate	15,500	38,000	53,500	10,700	29,700	40,400
(c) high	15,500	41,500	57,000	10,700	33,200	43,900
5. Site LBI plus Site SC2 (100 cfs and 60 cfs)	14,000	19,000	33,000	9,200	10,700	19,900
6. Site LBI (300 cfs and 60 cfs)	14,000	25,500	39,500	9,200	17,200	26,400
7. Site SC2 (100 cfs and 120 cfs)	12,800	20,000	32,800	8,000	11,700	19,700
8. Site 7B-1 plus Site LBI plus Site SC2 (300 cfs and 60 cfs)	14,000	44,300	58,300	9,200	36,000	45,200

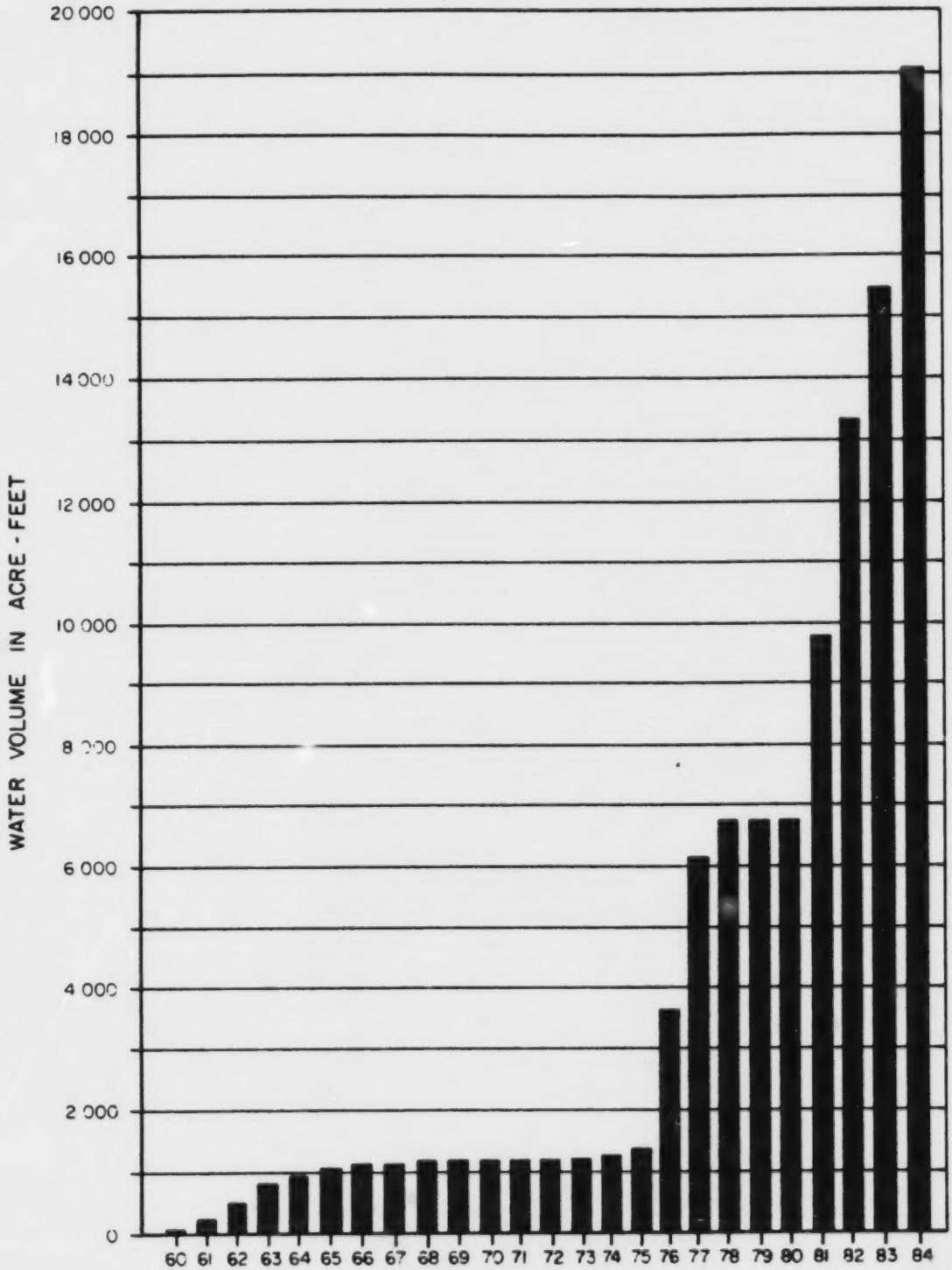
*Bracketed figures are capacities for the Little Bow Canal and Squaw Coulee Canal respectively.

**Assuming a 70 cfs minimum flow in the Highwood River.

***Based upon the following existing irrigated acreage estimates for 1985: Reach 1 (below Little Bow-Mosquito confluence) . 8,300 acres
Reach 2 (Little Bow above confluence). . . . . 2,900 acres } 4,800 acres
Reach 3 (Mosquito above confluence) . . . . . 1,900 acres
13,100 acres

Basic Data Source: Alberta Environment/Planning Division, Lethbridge, November 1985 and March 1986. Simulations conducted by Nanuk Engineering & Development Ltd.

Figure 3.1
ANNUAL LICENSED IRRIGATION ALLOCATION
LITTLE BOW RIVER BASIN



Source: Water Rights Branch, Alberta Environment.

Precisely which crops would be produced under irrigation in the future is difficult to predict. On the basis of discussions with local farmers, however, our expectation is that radical changes over time are unlikely, as suggested in Table 3.2:

Table 3.2

EXISTING AND PROJECTED CROP MIX WITH IRRIGATION

Crop	Crop Distribution 1983*	Local Farmer Expectations**	CONSENSUS
Wheat***	43	35	35
Barley	17	n.a.	5
Barley Silage			5
Canola	12	20	15
Flax	4		5
Hay (including alfalfa)	24	30	30
Specialty/Other	-	15	5
TOTAL	100%	100%	100%

*WER Engineering Ltd., *Little Bow River Basin Study: Analysis of Theoretical Crop Water Demand*, Alberta Environment, Calgary, April 1984.

**From discussions with local farmers.

***Mostly soft white wheat.

Projected yields under irrigation have been taken from previous studies[1] and recent discussions with local farmers.

The economic price projections are assumed to be similar to prices during 1972-84, all expressed in terms of constant 1985 dollars. These prices are often referred to as 'shadow prices' and reflect probable long-term real price levels in the international market, exclusive of subsidies or taxes. The financial product prices, in contrast, are approximately equal to 90 percent of actual prices in 1984. Reflecting the current downturn in agricultural product prices, the financial price projections are generally lower than the longer-term economic price projections.

Resulting crop revenue projections with irrigation are summarized in Appendix Table B-1.

Related costs of production for irrigated crops are summarized in Appendix Table B-2. These tabulations indicate that the estimated average net value-added (income) on a per-acre basis should be about:

	Financial	Economic
Gross Revenue	$316	$351
Production Costs	209	206
Net Value Added	$107	$145

[1] Alberta Agriculture, *Irrigation Water Requirements in the South Saskatchewan River Basin: Economic Analysis Component*, Edmonton, 1983.

Dryland

Similar calculations were conducted for the existing dryland crop production which would be replaced with the proposed irrigation. (Appendix Tables B-3/B-4.)

In this case, the crop mix reflects current cropping patterns and the expected yields are linear extrapolations based on regional data for the period 1974-83. The price projections are identical to expected product prices with irrigation (see above).

Current dryland costs-of-production again exclude all payments to land labor, management, and capital such that all residual revenues represent a composite value-added; income payable to the respective factors-of-production.

These estimates indicate that the average net value-added (income) for dryland crop production in the Little Bow River Basin on a per acre basis is probably about:

	Financial	Economic
Gross Revenue	$54	$65
Production Costs	42	40
Net Value Added	$12	$25

This is a weighted average for all dryland which reflects both improved (cultivated) and unimproved land.

Crop Summary

The focus of this study is on the *difference* in the per acre income (or net value added (NVA)) from crop production with and without irrigation in the Basin. Thus, our calculations suggest that this difference should *average*, in constant 1985 dollars, approximately:

	Financial	Economic
NVA Irrigation/Acre	$107	$145
NVA Dryland/Acre	12	25
NVA Difference/Acre	$ 95	$120

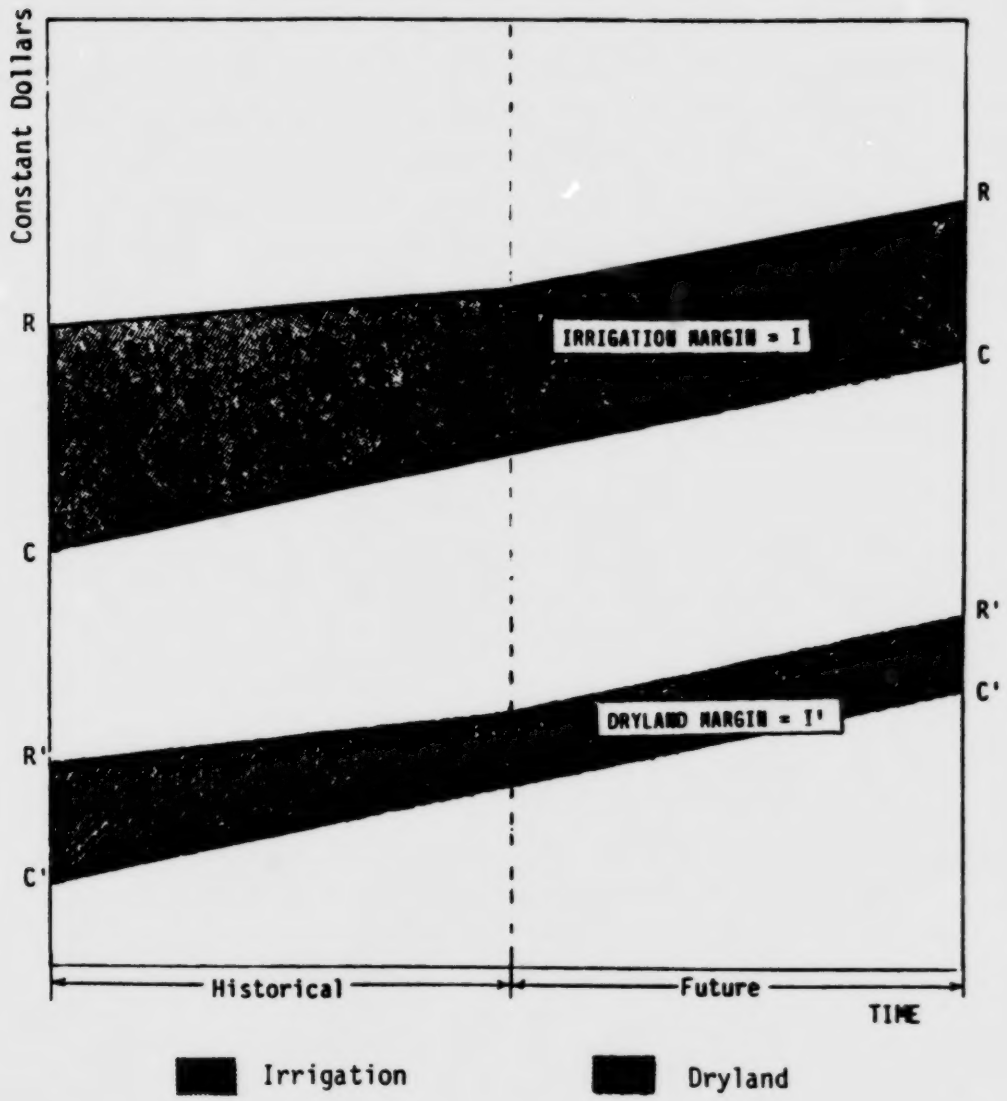
This value-added (or income) difference, in constant 1985 dollars, is further assumed to remain constant over the 30 year economic life of the project (see following), which also implicitly assumes that for both irrigation and dryland:

> Any real gross revenue increase (or real unit cost decrease) will be exactly offset by a real unit cost increase (or real gross revenue decrease) or vice versa by way of technological change, better management, economies of scale, crop mix changes, etc.

This is illustrated conceptually in Figure 3.2.

Figure 3.2

PROJECTED SCENARIO ASSUMING A CONSTANT INCREMENTAL MARGIN I-I'= I* ($ Constant)



3.3 Livestock Production and Stockwatering

An integral part of primary agricultural production in the Little Bow River Basin is livestock, particularly beef production. Indeed, livestock is often referred to as the most important "specialty crop" in the whole of Southern Alberta.

And here again, particularly since the publication of the *1981 Census of Agriculture*, it has become abundantly clear that irrigation also facilitates the integrated development of a much more intensive livestock sector. What is difficult is to accurately measure the relative extent of this livestock-crop interdependency.

This study employs two independent methodologies[1] to estimate this potential income change in the livestock industry which can be traced to irrigation in Census Division 3.

Methodology 1:

1. For both irrigation farms and dryland farms, calculate livestock numbers, grain consumption by livestock on these respective farms, and thus its market value;

2. Assume a 25 percent markup on the value of grain forage and pasture consumed by livestock in the region and then translate this into a per-acre incremental income estimate for the entire livestock sector, and then

3. Calculate the net difference between irrigation and dryland.

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[1]A third approach using multipliers is illustrated in earlier studies by the same authors. See MAA, *Oldman River Study, Phase II*, 1978; and *Milk River Study, Part II*, 1981.

For Census Division #3, in constant 1985 dollars per acre, this is estimated to amount to the following:[1]

	Financial	Economic
NVA Irrigation	$65.42	$68.99
NVA Dryland	4.96	6.32
Change in Value Added	$60.46	$62.67

Methodology 2:

1. Estimate the gross revenue per acre from livestock production for both irrigation and dryland in the region in question; and
2. Assume the net value-added (income) per acre from livestock production is 25 percent of gross revenue; and then
3. Calculate the net difference between irrigation and dryland.

In this case, the estimates are:

	Gross Revenue/Acre	Value Added
Irrigation	$268.16	$67.04
Dryland	37.07	9.27
Change in Value Added		$57.77

[1]Detailed budgets are available from the authors upon request.

A value of $60/acre appears to be representative of the incremental income gain from livestock which could be attributed to more irrigation in Census Division #3. In the Lower Little Bow Basin (where the proposed irrigation would be concentrated), however, the crop-livestock linkages are weaker and for this reason the simulations which follow employ a value of only $40/acre. (Also see Appendix D.)

3.4 Local Construction Expenditures

Short-term benefits also accrue to the *region* through the payment of salaries and wages to local construction personnel, plus the purchase of some local construction materials for the proposed project.

To calculate these benefits, it is estimated that:[1]

- Disposable income will represent about 75 percent of total regional labor construction costs and perhaps one-quarter of this disposable income will be spent within the study area.
- About 10 percent of total capital costs (less labor) will represent materials purchased within the study area, while the net value-added associated with these materials will be about 25 percent.

In addition, the respective material-labor expenditure ratio for the reservoir is estimated to be approximately 60 percent materials/ 40 percent labour.

With these data and the expenditure patterns already detailed (Sections 2.2 to 2.4), an estimate of the direct benefit of local construction expenditures to the region can be generated.

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[1] This methodology was originally developed in: Marv Anderson & Assoc., *Oldman River Basin Study, Phase II, Economic Analysis of Water Supply Alternatives*, Alberta Environment, Lethbridge, April 1978.

Although very significant to the region, these short-term benefits are not considered a net benefit to the province.

3.5 Indirect Benefits and Costs

When an industry (in this case agriculture) increases its output, it must obtain more inputs which are provided by other industries. This ripple-effect is termed a *backward linkage*. In addition, this same increase in output dictates an expansion in related industrial processing capacity. This is a *forward linkage*. In turn, the expansion of these other industries means increased demands are placed on their suppliers, and so on through a chain of interdependent industries. In total, this is referred to as the industry effect. In addition, as industries increase their production, they increase staff and thus pay more in wages. This increased income generates additional consumption and subsequent resulting increases in industry outputs. This is referred to as the income effect.

A closed input-output model generates total multipliers which capture both the industry and income effects by treating "households" as just another industry.

Increased demand (output) can, however, be met by either Alberta industry produced goods (i.e., domestic production), or imports, withdrawals from inventory, or government. These latter three sources are referred to as leakages from domestic production (i.e., demand which is met by other than Alberta industry produced goods) and to the extent these sources supplant domestic production in the supply of a commodity, the impact of an increase in final demand on domestic industries will be reduced.

The appropriate multipliers to employ to quantify the indirect net benefits of project implementation are therefore total ratio-form multipliers, with leakages, which are directly applicable to the value-added estimates calculated in Sections 3.2 and 3.3 preceding. These are provided in accompanying Table 3.3.

The specific multiplier of interest is 1.868. That is to say, for every $1 increase in the value-added of agriculture, about 87 cents in wages, salaries, and profits would also accrue to other Alberta industry.

This is the multiplier employed in the simulations which follow to calculate the respective socio-economic benefit-cost ratios for the province.

The inclusion of indirect (secondary) benefits and costs in this analysis is contingent upon the availability of unemployed resources such that expanding output in one region (or sector) would not imply a similar output reduction in another region (or sector).

In any case, the inclusion of indirect benefits in the economic analysis is most applicable when the decision-maker simply wants to know the general magnitude of the *total* benefits and costs which would arise from a proposed project, *assuming* that a decision has already been made to invest $X in Sector Y in Region Z. A strong case can be made for excluding indirect benefits from a provincial analysis which is deciding between two or more investment opportunities. In this situation, it is argued that the indirect benefits and costs would be similar irrespective of what project was considered and, therefore, largely irrelevant in the decision-making process.

Table 3.3

TOTAL MULTIPLIERS IN ALBERTA
(RATIO FORM, WITH LEAKAGES) BY MAJOR INDUSTRY, 1974

INDUSTRY	G.D.P. AT FACTOR COST*	GROSS OUTPUT
1. Agriculture	1.868	2.941
2. Forestry	2.855	3.221
3. Fishing, Hunting and Trapping	1.502	2.610
4. Mines, Quarries and Oil Wells	1.803	2.144
5. Manufacturing	3.315	2.827
6. Construction	2.318	2.654
7. Wholesale and Retail Trade	1.889	3.001
8. Transportation and Storage	2.143	2.816
9. Communications	1.624	2.558
10. Utilities	1.569	2.473
11. Finance, Insurance and Real Estate	1.490	2.147
12. Comm., Bus. and Personal Services	1.865	2.928

*Gross Domestic Product is approximately equal to Net Value Added.

Source: Alberta Treasury/Bureau of Statistics, *Economic Multipliers for Alberta Industries and Commodities*, Edmonton, March 1984, Table 4, p. 22.

3.6 Other Impacts

This study only quantifies the anticipated net benefits to the province of additional irrigation in the Little Bow region. Nevertheless, a number of other very real impacts are anticipated:

- enhanced habitat for fish and wildlife
- enhanced recreational opportunities
- improved water quality
- improved municipal and industrial water supplies
- enhanced economic stability

It is particularly important to note that during the initial years of the anticipated irrigation-development, the temporary "over-capacity" of a new reservoir would greatly facilitate improved water management in the Highwood. Improved streamflows in the Highwood (with lower diversions), particularly in the summer, could represent a very real benefit to the existing fishery.

These various potential non-agricultural benefits are addressed in detail in related Little Bow River Basin Studies[1] and must also very obviously be considered in the final decision-making process.

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[1]Alberta Environment, *Little Bow River Basin Study, Phase I Inventory of Reports*, Lethbridge, September 1985.

4. ECONOMIC ANALYSIS

4.1 Introduction

The purpose of this section is to compare the anticipated direct and indirect benefits of irrigation in the Little Bow River Basin with the offsetting direct and indirect costs.

The analysis following does not quantify related non-agricultural benefits or costs.

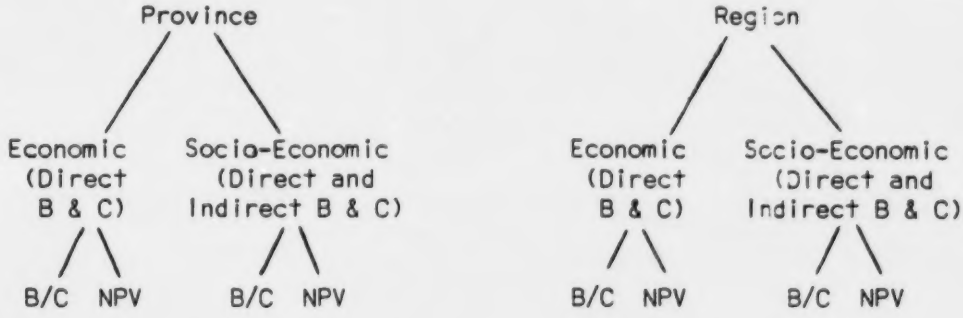
4.2 Methodology

Discounted cash flow analysis is used to generate two decision-making criteria: a *benefit-cost ratio* and a *net present value*.

$$B/C = \frac{\text{Sum of Discounted Tangible Incremental Benefits}}{\text{Sum of Discounted Tangible Incremental Costs}}$$

$$NPV = \text{Sum of Discounted Tangible Incremental Benefits } \textit{minus} \text{ Sum of Discounted Tangible Incremental Costs}$$

To be economically feasible, the Benefit-Cost Ratio (B/C) must exceed 1.0, and the Net Present Value (NPV) must be positive. The analysis can also be conducted from two different accounting stances: a provincial stance and a regional stance. And, in turn, each of these accounting stances has both an *economic* and *socio-economic* perspective.



Here defined, the *economic* perspective only looks at direct benefits and costs while the *socio-economic* perspective considers both direct and indirect benefits and costs.

More specifically, the provincial economic benefit-cost ratio is defined as follows:

$$\text{Provincial Economic B/C} = \frac{\text{GDB-AC}}{\text{TPC}} = \frac{\text{NDB}}{\text{TPC}}$$

where: GDB = gross direct benefits,

AC = associated costs,

NDB = net direct benefits,

TPC = total project costs.

$$\text{Provincial Socio-Economic B/C} = \frac{\text{(GDB-AC) + (GIB-GIC)}}{\text{TPC}} = \frac{\text{NDB + NIB}}{\text{TPC}}$$

where: NDB = net direct benefits,

NIB = net indirect benefits (province),

GDB = gross direct benefits,

AC = associated costs,

GIB = gross indirect benefits (province),

GIC = gross indirect costs (province), and

TPC = total project costs

Each of these ratios has its regional counterpart which is defined in an exactly analogous manner except that the regional socio-economic B/C also considers local short-term construction impacts.

4.3 Related Parameters

The cash flow analyses conducted following also relies on a number of underlying parameters. These are:

Prices:	Real constant 1985 dollars
Time-Frame:	30 years
(Real) Discount Rate:	7%

To eliminate the problem of changes in the general price level, all prices in this analysis are expressed in terms of *constant 1985 dollars*. The actual prices selected attempt to reflect projected average prices during the project period. The use of real 1985 dollars is consistent with the use of a real discount rate (see below).

In addition, *relative* prices are assumed not to change over the project life. Quantifying anticipated price changes in any meaningful way is extremely difficult.

The significant *economic life of a project* is the time required such that 90 percent or more of the cumulative present value of the benefits and costs are obtained. Thus, although the respective dams are expected to have a physical life in excess of 50 years, for the purposes of this report the economic life of the project is assumed to be only 30 years, including the project construction period.

Finally, because benefits and costs do not all accrue immediately, future payments must be discounted to their 'present value.' The *discount rate* can be interpreted as the opportunity cost of capital or as a time preference for current as opposed to future consumption. Generally, the higher the discount rate, the less attractive the project. For the purposes of this report, a basic real discount rate of seven percent per annum is employed.

4.4 Provincial Analysis

Base Case

The empirical results are summarized in accompanying Table 4.1 and clearly indicate that almost all of these potential reservoirs should be economically feasible.

From a purely economic perspective with regard to agriculture, two sites appear superior:

- Site 7B-1 with increased canal capacity
- Site LB1 with increased canal capacity

Site 7B-1, however, because of its relatively larger size, has the potential to generate a slightly higher Net Present Value over the 30 year economic project period. For this additional reason, it might be the preferred option.

If Site 7B-1 was the site selected, the analysis would further suggest that either the low or intermediate-sized reservoirs might be preferable. The economic simulations effectively penalize one-time "overbuilding"

Table 4.1

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC BENEFIT-COST RATIOS FOR AGRICULTURE*
LITTLE BOW RIVER BASIN

Reservoir Site**	ECONOMIC ANALYSIS		SOCIO-ECONOMIC ANALYSIS***	
	B/C Ratios	NPV ($M)	B/C Ratios	NPV ($M)
1. Site LBI (100 cfs and 60 cfs)	1.39	7.9	2.59	32.2
2. Site SC2 (100 cfs and 60 cfs)	1.28	5.0	2.39	24.8
3. Site 7A (300 cfs and 60 cfs)	1.10	5.2	2.06	53.1
4. Site 7B-1 (300 cfs and 60 cfs)				
(a) low	1.47	15.0	2.74	55.8
(b) intermediate	1.39	14.8	2.60	60.5
(c) high	1.31	13.2	2.45	61.1
5. Site LBI plus SC2 (100 cfs and 60 cfs)	1.05	1.4	1.96	28.8
6. Site LBI (300 cfs and 60 cfs)	1.49	13.0	2.79	47.2
7. Site SC2 (100 cfs and 120 cfs)	1.39	8.8	2.60	35.9
8. Site 7B-1 plus Site LBI plus Site SC2 (300 cfs and 60 cfs)	0.95	(3.1)	1.77	45.6

* Total costs versus the net benefits to agriculture.

** Bracketed figures are capacities for the Little Bow Canal and Squaw Coulee Canal respectively.

*** Also considers provincial "spinoffs" from agriculture, particularly relevant to satisfy regional development objectives.

Source: Appendix C.

because full utilization of the water for irrigation purposes would take more time for a larger reservoir than for a smaller reservoir.[1] Furthermore, on-farm irrigation development becomes increasingly costly as the more distant/higher elevation and/or marginal lands in the Basin are eventually serviced. Nevertheless, the Net Present Values for all of these 7B-1 options are fairly similar (i.e. between $13M and $15M).

Aside from Site 7B-1, Site LB1 (with increased canal capacity) would also be considered a very feasible economic development opportunity. This proposed development has a benefit-cost ratio of 1.49 and a relatively attrative Net Present Value of about $13 million. The important point here, however, is that this development should definitely be accompanied by additional canal capacity. Without this increased canal capacity, LB1 would appear to be a much poorer investment opportunity.

The worst economic choices from an agricultural perspective and according to this analysis would be:

- Site 7A
- Sites LB1 + SC2
- Sites 7B-1 + LB1 + SC2

Focusing exclusively on agriculture, these sites or site combinations would appear to be marginal investment opportunities.

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[1] In other words, no value is assigned to the short-term benefits of better streamflows which would accrue to non-agricultural users during the irrigation development period (5-10 years). (Section 3.6.)

The socio-economic analysis does not generally change these rankings. What this supplementary analysis indicates is that considering the regional/provincial spinoffs from more intensive agricultural operations in the Basin, the provincial benefit-cost ratios should almost double. Perhaps even more important, however, is the fact that the respective (direct + indirect) Net Present Values would likely be four or five times as large as the direct NPV's. These returns, over and above the 7 percent real rate of return implicit in the analysis, represent an impressive "profit" margin. Moreover, in contrast to the economic (direct) NPV of the respective Sites, the relative socio-economic NPV's tend to more closely parallel relative reservoir sizes. For example, here Site 7B-1 (int.) and 7B-1 (high) appear to be the preferred options.

In general, these expected rates-of-return are relatively good. They compare very favorably with other irrigation development proposals in Southern Alberta, both past and present. This comparative advantage stems from (a) the nature of the proposed development itself, and (b) the relative pay-off to irrigation in this Nanton-Carmangay region vis-a-vis other regions. Since the proposals only involve direct pumping by local farmers (with no relatively costly distribution canals), unit development costs are relatively low. In addition, intensification of the crop and livestock sectors similar to that of the Lethbridge Northern Irrigation District should generate a relatively high incremental net benefit to irrigated agriculture in the Basin.

In summary, at least the economically preferred sites identified in this analysis should be very feasible investment opportunities.

This is particularly true when we also consider the other very real non-agricultural benefits which could be realized:

- enhanced habitat for fish and wildlife
- enhanced recreational opportunities
- improved water quality
- improved municipal and industrial water supplies
- enhanced economic stability

In a comparative sense, we are relatively confident that these rankings are valid. But in an absolute sense, the reader should not be misled by the apparent (but potentially deceptive) precision of the respective benefit-cost ratios and related Net Present Values. The absolute value of virtually all benefit-cost ratios can realistically error by as much as *20 percent*[1] and for this reason a number of additional simulations are conducted immediately following.

Sensitivity Tests

To determine how much confidence we can put in the Base Case analysis, given that virtually all of the anticipated costs, projected benefits and underlying parameters are subject to at least some uncertainty in the future, a number of alternative development scenarios were also simulated. These are summarized in accompanying Tables 4.2 and 4.3.

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[1]United Nations, *Guide to Practical Project Appraisal*, UNIDO, New York, 1978.

Table 4.2

SENSITIVITY OF THE ECONOMIC BENEFIT-COST RATIOS TO CHANGES IN VARIOUS COSTS AND BENEFITS

Variable Change		Alternative Reservoir Sites									
		LB1	SC2	7A	7B-1 Low	7B-1 Intermediate	7B-1 High	LB1+SC2	LB1+	SC2+	7B-1+LB1+SC2
BASE CASE B/C RATIO		1.39	1.28	1.10	1.47	1.39	1.31	1.05	1.49	1.39	0.95
CHANGE											
Reservoir Costs Change	-20%	1.52	1.42	1.22	1.57	1.49	1.42	1.18	1.61	1.53	1.06
	+20%	1.27	1.16	1.01	1.37	1.31	1.22	.94	1.39	1.28	.86
Delivery Costs Change	-20%	1.40	1.29	1.12	1.49	1.42	1.34	1.06	1.52	1.41	.96
	+20%	1.37	1.27	1.08	1.44	1.36	1.29	1.04	1.47	1.38	.93
On-Farm Irrigation System Costs Change	-20%	1.54	1.41	1.21	1.66	1.57	1.47	1.13	1.68	1.55	1.03
	+20%	1.26	1.17	1.01	1.31	1.25	1.19	.97	1.34	1.26	.88
Incremental Net Crop Returns Change	-20%	1.18	1.09	.94	1.25	1.18	1.12	.89	1.27	1.18	.81
	+20%	1.59	1.47	1.27	1.69	1.60	1.51	1.20	1.72	1.60	1.09
Incremental Net Livestock Returns Change	-20%	1.32	1.21	1.05	1.39	1.32	1.25	1.00	1.42	1.32	.90
	+20%	1.46	1.34	1.16	1.54	1.46	1.38	1.10	1.57	1.64	.99
Time Frame is Extended to 50 Years		1.51	1.39	1.23	1.61	1.54	1.46	1.15	1.63	1.52	1.06
Real Discount Rate = 5%		1.58	1.46	1.27	1.65	1.58	1.49	1.22	1.69	1.59	1.10

Table 4.3

SENSITIVITY OF THE ECONOMIC NET PRESENT VALUES TO CHANGES IN VARIOUS COSTS AND BENEFITS*
($ 1985 Millions)

Variable Change		Alternative Reservoir Sites									
		LBI	SC2	7A	7B-1			LBI+SC 2	LBI+	SC2+	7B-1+LBI+SC2
					Low	Intermediate	High				
BASE CASE NPV		7.9	5.0	5.2	15.0	14.8	13.2	1.4	13.0	8.8	(3.1)
CHANGE											
Reservoir Costs Change	-20%	9.7	6.8	9.8	17.0	17.4	16.2	4.9	14.9	10.8	3.3
	+20%	6.0	3.1	0.5	12.8	12.3	10.1	(2.1)	11.1	6.8	(9.5)
Delivery Costs Change	-20%	8.0	5.1	6.1	15.6	15.6	14.0	1.7	13.4	9.0	2.2
	+20%	7.7	4.8	4.3	14.4	14.1	12.3	1.2	12.6	8.6	(4.0)
On-Farm Irrigation System Costs Change	-20%	9.9	6.6	9.7	18.7	19.1	17.6	3.7	16.0	11.1	1.4
	+20%	5.8	3.3	0.7	11.3	10.6	8.7	(0.9)	10.0	6.5	(7.7)
Incremental Net Crop Returns Change	-20%	3.6	1.5	(3.1)	7.9	7.0	4.9	(3.3)	7.1	4.1	(11.6)
	+20%	12.1	8.4	13.5	22.0	22.7	21.5	6.2	18.9	13.5	5.3
Incremental Net Livestock Returns Change	-20%	6.4	3.8	2.4	12.6	12.2	10.4	(0.2)	11.0	7.2	(5.9)
	+20%	9.3	6.1	7.9	17.3	17.5	15.9	3.0	15.0	10.4	(0.3)
Time Frame is Extended to 50 Years		10.8	7.3	12.2	20.6	21.5	20.4	4.6	17.5	12.2	3.9
Real Discount Rate = 5%		13.3	9.2	15.6	24.4	25.5	24.2	7.3	21.0	14.9	6.8

*Negative Net Present Values indicated in brackets.

These simulations clearly indicate which benefits and costs are more or less critical in the derivation of the respective B/C ratio. This sensitivity to unexpected changes in various benefits or costs can best be expressed in terms of an *elasticity* which is defined as:

$$\ell = \frac{\% \text{ Change in B/C Ratio}}{\% \text{ Change in a Specific Benefit or Cost}}$$

The larger the elasticity, the more the B/C ratio changes if the value of the variable in question also changes. The respective elasticities are approximately as follows:[1]

	Variable	Elasticity
COSTS:	Reservoir	- .44
	Delivery	- .08
	On-Farm System	- .48
	TOTAL	-1.00
BENEFITS:	Crops	+ .67
	Livestock	+ .33
	TOTAL	+1.00

For example, if actual reservoir costs unexpectedly climbed 20 percent, then the B/C ratio would probably drop about:

$$20\% \times .44 \simeq 9\%$$

And given a B/C ratio of, say 1.50, this would imply an adjusted B/C ratio of about:

$$1.50 - (1.50 \times .09) = \underline{\underline{1.37}}$$

And so on for any of the other benefits and costs.

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[1]An average for the ten Base Cases here considered.

In terms of *discounted* benefits and costs, these elasticities also represent the relative share of both real capital costs and cumulative real net benefits anticipated over a 30 year period. Thus, the summation of the respective benefit-related elasticities and cost-related elasticities both equal 1.0.

In addition, Table 4.2 indicates how two of the underlying parameters (Section 4.3) also affect the B/C ratio. By truncating the time-frame (to 30 years instead of 50 years) the B/C ratios drop about 10 percent. And, similarly, by employing a real discount rate (interest rate) of 7 percent instead of, say, 5 percent, the B/C ratios drop about 15 percent.

The accompanying Net Present Value changes (Table 4.3) indicate how sensitive these real values are to even minute changes in the underlying assumptions. A twenty percent error in only one underlying variable estimate could easily translate into a (say) $5 million dollar change in the NPV of any one of the larger proposals. And once again, cumulative errors would also have a cumulative impact on these particular values.

Finally, alternative scenarios can also be simulated to establish a "shadow price" for non-quantifiable benefits which could accrue to the region with different water management regimes. Consider, for example, the impact on the potential irrigated acreage with Site 7B-1 if minimum streamflows were increased 2-3 times to futher improve the fish habitat or, conversely, consider the case where there was

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[1]Simulations conducted by Nanuk Engineering & Development Ltd., Calgary, November 1985. Assumes 300 cfs in the Little Bow Canal and does not include a 15 cfs (10,500 acre feet) municipal and riparian flow. (Also see Table 3.1.)

a maximum 500 cfs diversion from the Highwood (or a 300 cfs diversion with flow regulation) such that the irrigated acreage in the Little Bow region could increase to some 70,000 acres. (Table 4.4)

The economic implications of these changes are indicated in Table 4.5 and clearly indicate what direct benefits would be lost/gained by agriculture if different water regimes were established. For example, if the high 7B-1 reservoir was constructed and the minimum flow downstream of High River was increased from 70 cfs to 175 cfs, this would cost agriculture about $282,000/annum. If minimum flows were further increased to 250 cfs, the annual cost would climb to about $451,000/year. Conversely, if diversions from the Highwood were increased, the additional benefits to agriculture could climb by about $169,000/annum. These are essentially *opportunity costs* and, as such, each represents a *shadow price* for the alternative values (especially fish and wildlife) being maintained. This is at least a first approximation to the dollar value of what society would be giving up in the agricultural sector to maintain or enhance other less quantifiable benefits or vice-versa.

4.5 Regional Analysis

From a regional perspective, local construction expenditures would also represent a very real short-term economic benefit to the area. (Section 3.5)

Table 4.4

ALTERNATIVE WATER MANAGEMENT SCENARIOS FOR SITE 7B-1 (300cfs)

Simulation	Reservoir Size	Minimum Downstream Flow (cfs)	Potential Incremental Irrigation Development (acres)*
#1	low	70	33,900
(BASE CASE	int.	70	40,400
7B-1)	high	70	43,900
	low	175	20,200 (-13,700)
#2	int.	175	28,700 (-11,700)
	high	175	32,200 (-11,700)
	low	250	13,700 (-20,200)
#3	int.	250	23,200 (-17,200)
	high	250	27,200 (-16,700)
#4**	high	70	56,900 (+13,000)

*Acreage change from Base Case indicated in brackets.
**Less restrictive diversions from the Highwood.

Table 4.5

ECONOMIC EVALUATION OF ALTERNATIVE WATER MANAGEMENT SCENARIOS FOR SITE 7B-1 (300 cfs)

Simulation	Reservoir Size	Economic B/C Ratio*	Loss/Gain in Net Present Value to Agriculture	
			$ Million	Average Annual Loss/Gain $1985
	low	1.36(1.47)	-$6.5M	-$524,000
#2	int.	1.35(1.39)	- 4.0	-$322,000
	high	1.27(1.31)	- 3.5	-$282,000
	low	1.18(1.47)	-11.5	-$927,000
#3	int.	1.20(1.39)	- 9.0	-$725,000
	high	1.23(1.31)	- 5.6	-$451,000
#4	high	1.32(1.31)	2.1	$169,000

*Base Case estimates in brackets.

It is estimated that this provincial "transfer" to the Basin area during construction should amount to approximately the following:

1.	Site LBI (100 cfs and 60 cfs)	$ 745,000
2.	Site SC2 (100 cfs and 60 cfs)	737,000
3.	Site 7A (300 cfs and 60 cfs)	1,888,000
4.	Site 7B-1 (300 cfs and 60 cfs)	
	(a) low	859,000
	(b) intermediate	1,030,000
	(c) high	1,240,000
5.	Site LBI (100 cfs) plus SC2 (60 cfs)	1,415,000
6.	Site LBI (300 cfs and 60 cfs)	763,000
7.	Site SC2 (100 cfs and 120 cfs)	805,000
8.	Site 7B-1 plus Site LBI plus Site SC2 (300 cfs and 60 cfs)	2,588,000

This would represent about 9 percent of total capital costs; the remainder would be dissipated across other parts of the province.

Thus, what should be emphasized here is that although this construction activity would very obviously inject more money into the local economy for a couple of years, in the longer-run this would be dwarfed by the spinoffs from more intensive agricultural operations and related activity in the Basin. At project maturity, these local spinoffs would probably amount to between $2 M and $6 M annually. In turn, local and provincial government tax revenues would also increase.

5. FARM FINANCIAL ANALYSIS

5.1 Introduction

A farm financial analysis generally parallels the preceding economic analysis (Section 4) except that (a) all values are taken at market prices, ignoring inflation; (b) taxes are treated as costs and subsidies (and tax credits, etc.) as income; (c) paid wages are a cost; and (d) interest on the repayment of borrowed money is a cost. That is:

	Gross Revenue
less	Cost of Goods and Services
=	Gross Value-Added
less	Depreciation
=	Net Value-Added
plus/less	Subsidies and Taxes
=	Farm Income
less	Real Interest (and Paid Wages)
=	Family Income
less	Return to Family Labor and Management
=	Farm Profits[1]

[1]"Profits" are defined as the return on a farm family's own funds.

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Determining the profitability of an agricultural undertaking however, is a difficult task. Every farm is unique because each has its own unique resource base, product mix, management, capital structure, and location/elevation from the Little Bow River.

5.2 Analysis

The proposed irrigation expansion in the Little Bow River Basin would consist exclusively of private farm irrigation systems which would pump directly from the river. At the present time, the demand for water for more irrigated crop production greatly exceeds available supplies. (See Section 1.)

The central questions here are: (1) how can a farmer finance this investment?; and (2) are public funds available to assist in this development?

A general indication of the farm economies of investing in irrigated crop production in the Little Bow River Basin is provided in accompanying Table 5.1.

Given the existing relatively depressed condition in the agricultural sector, and similar to the purchase of dryland, the initial return to the land, labor, equity capital and management can be expected to be relatively low, almost negligible. During these initial years, farmers with borrowed capital typically "subsidize" this investment with revenues from other income sources such as off-farm employment (beginning farmers) or other on-farm operations (established farmers).

Table 5.1

FARM FINANCIAL ANALYSIS FOR 500 ACRES OF IRRIGATED CROP PRODUCTION
Little Bow River Basin

Year	Delivery/Sprinkler[a]		System O & M[b]		Production Costs[c]	TOTAL COSTS		GROSS REVENUE[d]	Residual[e]	
	Low	High	Low	High		Low	High		Low	High
1	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
2	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
3	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
4	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
5	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
6	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
7	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
8	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
9	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
10	40,320	48,730	12,500	17,500	104,500	157,320	170,730	158,000	680	-12,730
11-30	-	-	12,500	17,500	104,500	117,000	122,000	158,000	41,000	36,000
TOTAL (30 years)									$826,800	$592,700
Average/Annum/Acre									$55.12	$39.51

[a] Sprinkler = $380/acre; low cost delivery = $80/acre and high cost delivery = $175/acre. Net of a $2,200 PFRA grant. Amortized at 12%/annum over 10 years.

[b] O & M Costs of $25/acre and $35/acre respectively.

[c] $209/acre.

[d] $316/acre.

[e] Return to land, labor, equity capital, and management.

Eventually, however, without a mandatory repayment to non-equity capital, the net return to the producer climbs. Over, say, 30 years, it ultimately "makes sense." The average net return over this period should amount to four or five times as much as an equal dryland acreage.

Available PFRA grants for individual pumping schemes ($2,200/project) may act as a very modest short-run investment incentive but they have essentially no impact on the long-term profitability of irrigated crop production in this Basin or elsewhere. No other public funds are available.

Table 5.1 may nevertheless underestimate the farmers' ability-to-pay to the extent that he can take advantage of available income tax credits or lower-interest, longer-term financing.[1] These simulations also ignore other inherent advantages to irrigation:

- using before-tax dollars to develop the irrigation system versus after-tax dollars to purchase more dryland
- greater production stability/less financial risk with irrigation -- almost mandatory with today's high technology/narrow margin agriculture
- more crop diversity and, hence, more market alternatives, etc.

With irrigation, there are simply many more opportunities for good management to excel. These advantages aside, what are the alternatives and what is the relative payoff to these other farm investment options? This alternative is often the purchase of additional

---

[1] The Agricultural Development Corporation is now offering longer-term credit at a fixed interest rate of 9 percent per annum.

dryland which is an even less profitable option, as illustrated following: ($/acre 1985)

	Irrigation	Dryland
Land Price	$ 436	$436
Delivery System	80-175	-
Sprinkler	380	-
TOTAL	$896-991	$436
RATIO	2:1	

At the present time, farm irrigation facilities essentially cost about the same as an equivalent dryland acreage.

Yet this 2:1 investment ratio is totally inconsistent with the relative net return to the two technologies: ($/acre 1985)

	Irrigation	Dryland
Gross Revenue	$316	$54
Costs-of-Production	209	42
Net Return	$107	12
RATIO	8:1	

The appropriate investment ratio should probably be closer to 5:1 rather than the existing 2:1.

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[1]For County #2. See: Alberta Agriculture, *The Alberta Agricultural Real Estate Situation*, Edmonton, quarterly reports, 1985.

This underlying inconsistency can generally be traced to an inflated market price for dryland. In terms of its agricultural productivity, dryland is presently over-valued.[1] At a price for dryland of, say, $250/acre, the comparative advantage of irrigation would not be so self-evident.

In any event, the long term trend in agriculture towards more intensive, high-technology production would generally suggest that it is unlikely that the long-run demand for water for additional irrigation in the Little Bow River Basin will diminish. Indeed, it is much more likely that this demand will increase, perhaps exponentually and probably indefinitely.

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[1]A good rule-of-thumb is that land should sell for approximately ten times land rentals. The present over-valuation of dryland is typical in most areas of the province and elsewhere.

6. SUMMARY AND CONCLUSIONS

The overall objective of this study was to determine the *economic* and *financial* feasibility of developing additional storage to augment water supplies for irrigated agriculture in the Little Bow River Basin.

The ten potential water storage options considered are indicated in Table 6.1.

The study focuses exclusively on the anticipated benefits and costs to agriculture.

The basic methodology utilized is discounted cash flow analysis, a methodology which traces all the tangible incremental costs and benefits of a project over a 30 year time frame, adjusts future dollars to the present by using a 7 percent discount rate, and then compares the cumulative value of the projected benefit stream with the cumulative value of the anticipated cost stream.

To be economically or financially feasible, the Benefit-Cost Ratio (B/C) must exceed 1.0, and the Net Present Value (NPV) must be positive.

This assessment is conducted from three different accounting stances: farmers, the region, and the province.

From a provincial perspective, the basic empirical results are provided in accompanying Table 6.2 and clearly indicate that almost all of these potential reservoirs should be economically feasible.

Table 6.1

ALTERNATIVE STORAGE SITES IN THE LITTLE BOW RIVER BASIN: CAPACITIES, CAPITAL COSTS AND IRRIGATION POTENTIAL

Proposed Reservoir Site*	Reservoir Capacity (acre feet)	Capital Cost Estimate ($1985 million)	Additional Potential Irrigation (acres)
1. Site LB1 (100 cfs and 60 cfs)	17,250	8.3	17,400
2. Site SC2 (100 cfs and 60 cfs)	14,400	8.2	13,700
3. Site 7A (300 cfs and 60 cfs)	70,000	21.0	43,900
4. Site 7B-1 (300 cfs and 60 cfs)			
(a) low	30,000	9.5	33,900
(b) intermediate	50,000	11.4	40,400
(c) high	70,000	13.8	43,900
5. Site LB1 plus Site SC2 (100 cfs and 60 cfs)	31,650	15.7	19,900
6. Site LB1 (300 cfs and 60 cfs)	17,250	8.5	26,400
7. Site SC2 (100 cfs and 120 cfs)	14,400	8.9	19,700
8. Site 7B-1 plus Site LB1 plus Site SC2 (300 cfs and 60 cfs)	101,650	28.8	45,200

*Bracketed figures are capacities for the Little Bow Canal and the Squaw Coulee Canal respectively.

Source: Tables 2.1 and 3.1.

Table 6.2

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC BENEFIT-COST RATIOS FOR AGRICULTURE*
LITTLE BOW RIVER BASIN

Reservoir Site**	ECONOMIC ANALYSIS		SOCIO-ECONOMIC ANALYSIS***	
	B/C Ratios	NPV ($M)	B/C Ratios	NPV ($M)
1. Site LBI (100 cfs and 60 cfs)	1.39	7.9	2.59	32.2
2. Site SC2 (100 cfs and 60 cfs)	1.28	5.0	2.39	24.8
3. Site 7A (300 cfs and 60 cfs)	1.10	5.2	2.06	53.1
4. Site 7B-1 (300 cfs and 60 cfs)				
(a) low	1.47	15.0	2.74	55.8
(b) intermediate	1.39	14.8	2.60	60.5
(c) high	1.31	13.2	2.45	61.1
5. Site LBI plus SC2 (100 cfs and 60 cfs)	1.05	1.4	1.96	28.8
6. Site LBI (300 cfs and 60 cfs)	1.49	13.0	2.79	47.2
7. Site SC2 (100 cfs and 120 cfs)	1.39	8.8	2.60	35.9
8. Site 7B-1 plus Site LBI plus Site SC2 (300 cfs and 60 cfs)	0.95	(3.1)	1.77	45.6

* Total costs versus the net benefits to agriculture.

** Bracketed figures are capacities for the Little Bow Canal and Squaw Coulee Canal respectively.

*** Also considers provincial "spinoffs" from agriculture, particularly relevant to satisfy regional development objectives.

Nevertheless, using these economic efficiency criteria with respect to agriculture, two sites appear somewhat better:

- Site 7B-1 with increased canal capacity
- Site LB1 with increased canal capacity

Site 7B-1, because of its relatively larger size, has the potential to generate a slightly higher Net Present Value over the 30 year project period and for this reason it might be the best option.

It appears to be particularly important that either of these developments be accompanied by additional canal capacity.

Conversly, the worst economic choices would be:

- Site 7A
- Sites LB1 + SC2
- Sites 7B-1 + LB1 + SC2

Focusing exclusively on agriculture, these options would appear to be marginal investment opportunities.

The socio-economic analysis does not change these basic conclusions. What this supplementary analysis indicates is that considering the regional/provincial spinoffs from more intensive agricultural operations in the Basin, the provincial B/C ratios should almost double. Perhaps even more important, however, is the fact that the respective (direct + indirect) Net Present Values would be four or five times as large as the direct NPV's. This return, over and above the 7 percent real rate of return implicit in the analysis represents an impressive "profit" margin.

In general, the expected rates-of-return are relatively good. They compare very favorably with other irrigation development proposals in Southern Alberta, both past and present. This comparative advantage stems from (a) the nature of the proposed development itself, and (b) the relative pay-off to irrigation in this Nanton-Carmangay region vis-a-vis other regions. Since the proposals only involve direct pumping by local farmers (with no relatively costly off-stream systems), unit development costs are relatively low. In addition, intensification of the crop and livestock sectors similar to that of the Lethbridge Northern Irrigation District should generate a relatively high incremental net benefit to irrigated agriculture in the Basin.

Also considering the anticipated net direct benefits to other sectors of the economy would only reinforce our general conclusion that at least the economically preferred sites in this analysis should be very feasible investment opportunities.

From a regional perspective, short-term construction expenditures would also have a generally positive economic impact on local communities; an income injection of between $1 M and $4.2 M over a two year period. But in the longer-term, this would be dwarfed by the spinoffs from more intensive agricultural operations and related activity in the Basin.

Finally, a brief assessment of the financial implications of on-farm irrigation development in the Basin indicates that farm profitability is largely dependent upon a farmers' particular resource base, product mix, management, capital structure, and location/elevation from the Little Bow River. In any event, the investment

must be considered a long-term (20-30 year) investment in a non-depreciating capital resource. Modest short-term rates-of-return generally mirror the depressed conditions which presently plague the entire agricultural industry. Even in this context, however, irrigated agriculture has a comparative advantage over dryland agriculture.

APPENDIX

APPENDIX A

TERMS OF REFERENCE

Using appropriate methodologies and analytical techniques, the consultant will undertake an economic analysis of proposed water storage projects in the Little Bow River Basin. The analysis will be from a provincial perspective and will include primary and secondary net benefit determination and the distribution of benefits and costs.

Ten alternative sites are to be considered:

A. For each alternative that is being considered, the consultant will:

   1. Indicate the additional area and location of land in the basin that could be irrigated if additional storage was provided.

   2. Estimate the increased gross and net revenue to farmers because of a change from dryland to irrigation farming.

   3. Indicate the capital and operating costs that would be associated with providing storage for irrigation.

   4. Identify and, if possible, quantify any secondary costs and benefits which would be expected if the project was implemented.

   5. Determine the economic feasibility of the alternatives.

B. The alternatives will be ranked in terms of their economic feasibility.

C. Sensitivity analysis will be undertaken for those variables having the greatest degree of uncertainty.

D. Estimate the possible impact of P.F.R.A. assistance programs:

   i) from a farm financial perspective
   ii) from the point of view of distribution of costs and benefits.

APPENDIX B

BACKGROUND DATA FOR FARM BUDGETS

Table B-1

CROP MIX, YIELDS, PRICES AND CROP REVENUE WITH IRRIGATION IN THE LITTLE BOW RIVER BASIN, 1985-86

Land Use	Area[a] (100 Acres)	Yields[b] per Acre	Prices[c]		TOTAL REVENUE PER 100 ACRES	
			Financial	Economic	Financial	Economic
Wheat (soft white)	35	80	3.17	3.74	8,876	10,472
Barley[d]	5	95	2.16	2.61	1,026	1,240
Canola	15	49	6.57	7.46	4,829	5,483
Flax	5	40	6.57	8.73	1,314	1,746
Hay/Alfalfa[e]	30	4.0	76.16	62.11	9,139	7,453
Barley Silage (90% D.M.)[f]	5	8.0	49.00	61.00	1,960	2,440
Other ("Specialty")[g]	5	-	-	-	4,535	6,250
TOTAL	100				31,679	35,084
WEIGHTED AVERAGE/ACRE (per hectare)					$316 ($782)	$351 ($867)

[a] For rationale, see text.

[b] Yields generally taken from: Alberta Agriculture, *Irrigation Water Requirements in the South Saskatchewan River Basin: Economic Component*, Resource Economics Branch, Edmonton, February 1983. (Agroclimatic Zone C.) All yields based on a water application rate of 36.6 cm (144"). Grain and oilseed yields expressed in bushels/acre; forage yields provided in (metric) tonnes per acre.

[c] Financial prices = 90.7% of 1984 prices; consistent with the decline in the Index of Ag. Farm Product Prices for Alberta in 1985. Economic prices = average 1972-84 prices, expressed in terms of of $ 1985. Deflated by the Agricultural Product Price Index (Alberta) where September 1985 = 100.0.

[d] Sometimes good quality barley can be sold for malt for a premium of approximately $1.00/bushel.

[e] Good quality hay/alfalfa can sometimes be sold to neighboring dairies for a premium of approximately $10/tonne.

[f] Yields and prices tied to barley grain. Estimated by local beef feedlot operators.

[g] Based on an historical analysis of CD #3.

Table B-2

COSTS OF PRODUCTION FOR IRRIGATED CROPS IN THE LITTLE BOW RIVER BASIN, 1985-86
(per acre)

ITEM / CROP	Seed	Fertilizer	Chemicals	Taxes	Insurance	Machinery Operation and Repairs[a/]		Miscellaneous Overhead		Interest on Operating Capital	SUB-TOTAL	Depreciation		TOTAL
						Fuel	Repairs	Buildings	Other			Buildings	Machinery	
Wheat	9.37	48.70	17.05	3.00	6.00	23.80	20.48	1.89	15.41	7.75	153.45	6.13	44.12	203.70
Barley	5.71	42.34	17.93	3.00	6.00	24.04	19.68	1.89	14.63	7.36	142.58	6.96	42.39	191.93
Canola	4.21	67.21	24.93	3.00	6.00	22.59	19.25	1.89	14.64	8.42	172.14	3.00	41.45	216.59
Flax	5.53	52.93	25.49	3.00	6.00	23.08	19.05	1.89	14.64	8.49	160.10	4.62	41.02	205.74
Hay/Alfalfa	5.00	30.16	-	3.00	-	22.59	17.00	1.89	13.75	3.82	97.21	3.00	36.61	136.82
Barley Silage	5.71	42.34	17.93	3.00	6.00	24.04	19.68	1.89	14.63	7.36	142.58	6.96	42.39	191.93
Other ("Specialty")[b/]	47.28	118.22	176.07	3.00	6.00	79.72	62.85	1.89	46.67	30.29	571.99	3.00	110.35	685.34
WEIGHTED AVERAGE/ACRE	8.62	48.97	21.58	3.00	4.20	26.04	21.22	1.89	16.24	7.80	159.56	4.57	44.45	208.58
(per hectare)														(515.18)

[a/] Excluding O & M Costs for the center pivot.

[b/] Based on historical data for CD #3.

Basic Sources: Reconciled from data available from Statistics Canada (Census of Ag., 1981), Alberta Treasury (provincial accounts), and Alberta Agriculture (Ag. Stats. and CRD's). Cereal seed and fertilizer costs adjusted downward 30% and 20% respectfully. Taxes and insurance costs based on local farmer estimates.

Table B-3

CROP MIX, YIELDS, PRICES AND CROP REVENUE WITH DRYLAND IN THE LITTLE BOW RIVER BASIN, 1985-86

Land Use	Area[a] (100 Acres)	Yields[b] per Acre	Prices[c] Financial	Prices[c] Economic	TOTAL REVENUE PER 100 ACRES Financial	TOTAL REVENUE PER 100 ACRES Economic
IMPROVED						
Wheat (including durum and winter wheat)	43	25.0	3.96	4.68	4,257	5,031
Rye (fall)	8	37.0	2.03	3.22	601	953
Oilseeds (Canola)	4	17.0	6.57	7.46	447	507
Hay	negl.	.75	76.16	62.11	-	-
Improved Pasture	negl.	1.02 AUM	11.39	9.40	-	-
Summerfallow	30	-	-	-	-	-
UNIMPROVED	15	.35 AUM	11.39	9.40	60	49
TOTAL	100				5,365	6,540
WEIGHTED AVERAGE/ACRE (per hectare)					$54 ($133)	$65 ($161)

[a] Based on discussions with local farmers.

[b] Projected 1985 yields based on a linear trend line for the period 1974-83, net of irrigation. For the basic data, see Alberta Agriculture, *Agricultural Statistics Yearbook*, Edmonton, various years. Grain and oilseed yields expressed in bushels/acre; all other yields provided in (metric) tonnes per acre. AUM = animal unit month.

[c] Financial prices = 90% of 1984 prices; consistent with the decline in the Index of Ag. Farm Product Prices for Alberta in 1985. Economic prices = average 1972-84 prices, expressed in terms of $ 1985. Deflated by the Agricultural Product Price Index (Alberta) where September 1985 = 100.0. Pasture prices = private grazing rates = 1.53 x public grazing reserve rates.

Table B-4

COSTS OF PRODUCTION FOR DRYLAND CROPS IN THE LITTLE BOW RIVER BASIN, 1985-86
(per acre)

ITEM / CROP	Seed	Fertilizer	Chemical	Crop Insurance	Taxes	Machinery Operation and Repairs		Miscellaneous Overhead		Interest on Operating Capital	SUB-TOTAL	Depreciation		TOTAL
						Fuel	Repairs	Buildings	Other			Buildings	Machinery	
Wheat	6.50	10.38	6.00	4.00	2.00	7.22	5.74	.67	4.18	1.42	48.11	2.14	16.09	66.34
Rye	5.61	10.38	-	4.00	2.00	6.86	5.46	.67	3.75	1.03	39.76	3.17	14.00	56.93
Canola	3.66	12.35	8.00	4.00	2.00	6.78	5.51	.67	4.66	1.63	49.26	2.10	16.35	67.71
Summerfallow	-	-	-	-	2.00	3.32	2.81	.67	.91	.20	9.91	1.07	6.18	17.16
UNIMPROVED	-	-	-	-	2.00	-	-	-	-	-	2.00	-	-	2.00
WEIGHTED AVERAGE/ACRE (per hectare)	3.39	5.79	2.90	2.20	2.00	4.92	3.97	.57	2.56	.82	29.12	1.58	10.80	41.50 (102.50)

Basic Sources: Initially reconciled from data available from Statistics Canada (Census of Ag., 1981), Alberta Treasury (provincial accounts), and Alberta Agriculture (Ag. Stats. and CRD's). Subsequently adjusted by reducing seed and fertilizer costs 30% and 20% respectfully and machinery O & M by 25%. Interest costs = 6% of fertilizer, chemical and fuel costs. Taxes, insurance costs and chemical costs based on local farmer estimates. Also see: Alberta Agriculture, *Crop Enterprise Analysis: Vulcan-Champion District*, December 6, 1985.

APPENDIX C

SIMULATIONS

Table C-1

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE LB1 (100 cfs)
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	3,310	-	-	-	-	-	3,310	3,094	-	-	-	-	-	-	-
2	-	4,965	-	-	-	-	-	4,965	4,336	-	-	-	-	-	-	-
3	10,500	-	166	534	-	3,990	285	4,975	4,061	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	166	306	-	1,330	388	2,190	1,671	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,400	--	166	445	-	1,292	493	2,395	1,708	2,088	696	2,417	2,784	1,985	5,201	3,708
6-30	17,400	-	166	-	-	-	493	659	5,476	2,088	696	2,417	2,784	23,132	5,201	43,215
PRESENT VALUE*									20,346(C)					28,197(B)		52,677(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.39	2.59
Net Present Value = B-C =	$7.9M	$32.3M

Table C-2

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE SC2 (100 cfs)
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	3,278	-	-	-	-	-	3,278	3,064	-	-	-	-	-	-	-
2	-	4,916	-	-	-	-	-	4,916	4,294	-	-	-	-	-	-	-
3	10,500		164	534	-	3,990	285	4,973	4,059	1,260	420	1,458	1,680	1,371	3,138	2,562
4	13,700		164	266	-	1,216	379	2,025	1,545	1,644	548	1,903	2,192	1,672	4,095	3,124
5-30	13,700		164	-	-	-	379	543	4,899	1,644	548	1,903	2,192	19,776	4,095	36,945
PRESENT VALUE*									17,861(C)					22,819(B)		42,631(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.28	2.39
Net Present Value = B-C =	$5.0M	$24.8M

Table C-3

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE 7A (300 cfs)
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	8,393	-	-	-	-	-	8,393	7,844	-	-	-	-	-	-	-
2	-	12,589	-	-	-	-	-	12,589	10,995	-	-	-	-	-	-	-
3	10,500	-	420	534	-	3,990	285	5,229	4,268	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	420	306	-	1,330	388	2,444	1,865	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	420	459	-	1,330	496	2,705	1,929	2,100	700	2,430	2,800	1,996	5,230	3,729
6	21,000	-	420	520	-	1,330	614	2,884	1,922	2,520	840	2,916	3,360	2,239	6,276	4,182
7	24,500	-	420	700	-	1,330	757	3,207	1,997	2,940	980	3,403	3,920	2,441	7,323	4,560
8	28,000	-	420	700	-	1,330	901	3,351	1,950	3,360	1,120	3,889	4,480	2,607	8,369	4,871
9	31,500	-	420	839	-	1,330	1,046	3,635	1,977	3,780	1,260	4,375	5,040	2,741	9,415	5,121
10	35,000	-	420	1,050	-	1,330	1,193	3,993	2,030	4,200	1,400	4,861	5,600	2,846	10,461	5,317
11	38,500	-	420	1,050	-	1,330	1,340	4,140	1,967	4,620	1,540	5,347	6,160	2,927	11,507	5,467
12	42,000	-	420	1,050	-	1,330	1,487	4,287	1,903	5,040	1,680	5,833	6,720	2,984	12,553	5,574
13	43,900	-	420	570	-	722	1,566	3,278	1,360	5,268	1,756	6,097	7,024	2,915	13,121	5,445
14-30	43,900	-	420	-	-	-	1,566	1,986	8,045	5,268	1,756	6,097	7,024	28,454	13,121	53,153
PRESENT VALUE*									50,052(C)					55,230(B)		103,173(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.10	2.06
Net Present Value = B-C =	$5.2M	$53.1M

Table C-4

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - 7B-1 (300 cfs) - LOW
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	3,818	-	-	-	-	-	3,818	3,568	-	-	-	-	-	-	-
2	-	5,728	-	-	-	-	-	5,728	5,003	-	-	-	-	-	-	-
3	10,500	-	191	534	-	3,990	285	5,000	4,082	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	191	306	-	1,330	388	2,215	1,690	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	191	459	-	1,330	496	2,476	1,765	2,100	700	2,430	2,800	1,996	5,230	3,729
6	21,000	-	191	520	-	1,330	614	2,655	1,769	2,520	840	2,916	3,360	2,239	6,276	4,182
7	24,500	-	191	700	-	1,330	757	2,978	1,854	2,940	980	3,403	3,920	2,441	7,323	4,560
8	28,000	-	191	700	-	1,330	901	3,122	1,817	3,360	1,120	3,889	4,480	2,607	8,369	4,871
9	31,500	-	191	839	-	1,330	1,046	3,406	1,853	3,780	1,260	4,375	5,040	2,741	9,415	5,121
10	33,900	-	191	720	-	912	1,147	2,970	1,510	4,068	1,356	4,708	5,424	2,757	10,132	5,150
11-30	33,900	-	191	-	-	-	1,147	1,338	7,206	4,068	1,356	4,708	5,424	29,210	10,132	54,564
PRESENT VALUE*									32,117(C)					47,072(B)		87,931(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.47	2.74
Net Present Value = B-C =	$15.0M	$55.8M

Table C-5

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - 7B-1 (300 cfs) - INTERMEDIATE
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock	Indirect	$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	4,579	-	-	-	-	-	4,579	4,280	-	-	-	-	-	-	-
2	-	6,869	-	-	-	-	-	6,869	5,999	-	-	-	-	-	-	-
3	10,500	-	229	534	-	3,990	285	5,038	4,113	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	229	306	-	1,330	388	2,253	1,719	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	229	459	-	1,330	496	2,514	1,792	2,100	700	2,430	2,800	1,996	5,230	3,729
6	21,000	-	229	520	-	1,330	614	2,693	1,794	2,520	840	2,916	3,360	2,239	6,276	4,182
7	24,500	-	229	700	-	1,330	757	3,016	1,878	2,940	980	3,403	3,920	2,441	7,323	4,560
8	28,000	-	229	700	-	1,330	901	3,160	1,839	3,360	1,120	3,889	4,480	2,607	8,369	4,871
9	31,500	-	229	839	-	1,330	1,046	3,444	1,873	3,780	1,260	4,375	5,040	2,741	9,415	5,121
10	35,000	-	229	1,050	-	1,330	1,193	3,802	1,933	4,200	1,400	4,861	5,600	2,846	10,461	5,317
11	38,500	-	229	1,050	-	1,330	1,340	3,949	1,876	4,620	1,540	5,347	6,160	2,927	11,507	5,467
12	40,400	-	229	570	-	722	1,420	2,941	1,306	4,848	1,616	5,611	6,464	2,870	12,075	5,361
13-30	40,400	-	229	-	-	-	1,420	1,649	7,364	4,848	1,616	5,611	6,464	28,868	12,075	53,927
PRESENT VALUE*									37,766(C)					52,615(B)		98,289(B*)

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.39	2.60
Net Present Value = B-C =	$14.8M	$ 0.5M

Table C-6

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - 7B-1 (300 cfs) - HIGH
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	5,512	-	-	-	-	-	5,512	5,152	-	-	-	-	-	-	-
2	-	8,269	-	-	-	-	-	8,269	7,222	-	-	-	-	-	-	-
3	10,500	-	276	534	-	3,990	285	5,085	4,151	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	276	306	-	1,330	388	2,300	1,755	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	276	459	-	1,330	496	2,561	1,826	2,100	700	2,430	2,800	1,996	5,230	3,729
6	21,000	-	276	520	-	1,330	614	2,740	1,826	2,520	840	2,916	3,360	2,239	6,276	4,182
7	24,500	-	276	700	-	1,330	757	3,063	1,907	2,940	980	3,403	3,920	2,441	7,323	4,560
8	28,000	-	276	700	-	1,330	901	3,207	1,866	3,360	1,120	3,889	4,480	2,607	8,369	4,871
9	31,500	-	276	839	-	1,330	1,046	3,491	1,899	3,780	1,260	4,375	5,040	2,741	9,415	5,121
10	35,000	-	276	1,050	-	1,330	1,193	3,649	1,956	4,200	1,400	4,861	5,600	2,846	10,461	5,317
11	38,500	-	276	1,050	-	1,330	1,340	3,996	1,898	4,620	1,540	5,347	6,160	2,927	11,507	5,467
12	42,000	-	276	1,050	-	1,330	1,487	4,143	1,839	5,040	1,680	5,833	6,720	2,984	12,553	5,574
13	43,900	-	276	570	-	722	1,566	3,134	1,301	5,268	1,756	6,097	7,024	2,915	13,121	5,445
14-30	43,900	-	276	-	-	-	1,566	1,842	7,462	5,268	1,756	6,097	7,024	28,454	13,121	53,153
PRESENT VALUE*									42,060(C)					55,230(B)		103,173(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ration = B/C =	1.31	2.45
Net Present Value = B-C =	$13.2M	$61.1M

Table C-7

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE LB1 PLUS SITE SC2 (100 cfs)
($ 000 1985)

Year	Area (acres)	INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
		Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	6,288	-	-	-	-	-	6,288	5,877	-	-	-	-	-	-	-
2	-	9,431	-	-	-	-	-	9,431	8,237	-	-	-	-	-	-	-
3	10,500	-	314	534	-	3,990	285	5,123	4,182	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	314	306	-	1,330	388	2,338	1,784	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	314	459	-	1,330	496	2,599	1,853	2,100	700	2,430	2,800	1,996	5,230	3,729
6	19,900	-	314	314	-	912	571	2,111	1,407	2,388	796	2,764	3,184	2,121	5,948	3,963
7-30	19,900	-	314	-	-	-	571	885	6,763	2,388	796	2,764	3,184	24,332	5,948	45,455
PRESENT VALUE*									30,103(C)					31,529(B)		58,901(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.05	1.96
Net Present Value = B-C =	$1.4M	$28.8M

Table C-8

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE L81 (300 cfs)
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	3,390	-	-	-	-	-	3,390	3,168	-	-	-	-	-	-	-
2	-	5,085	-	-	-	-	-	5,085	4,441	-	-	-	-	-	-	-
3	10,500	-	170	534	-	3,990	285	4,979	4,064	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	170	306	-	1,330	388	2,194	1,674	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	170	459	-	1,330	496	2,455	1,750	2,100	700	2,430	2,800	1,996	5,230	3,729
6	21,000	-	170	520	-	1,330	614	2,634	1,755	2,520	840	2,916	3,360	2,239	6,276	4,182
7	24,500	-	170	700	-	1,330	757	2,957	1,841	2,940	980	3,403	3,920	2,441	7,323	4,560
8	26,400	-	170	380	-	722	835	2,107	1,226	3,168	1,056	3,666	4,224	2,458	7,890	4,592
9-30	26,400	-	170	-	-	-	835	1,005	6,470	3,168	1,056	3,666	4,224	27,192	7,890	50,792
PRESENT VALUE*									26,389(C)					39,406(B)		73,609(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.49	2.79
Net Present Value = B-C =	$13.0M	$47.2M

Table C-9

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE SC2 (120 cfs)
($ 000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	3,578	-	-	-	-		3,578	3,344	-	-	-	-	-	-	-
2	-	5,366	-	-	-	-		5,366	4,687	-	-	-	-	-	-	-
3	10,500	-	179	534	-	3,990	285	4,988	4,072	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	179	306	-	1,330	388	2,203	1,681	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	179	459	-	1,330	496	2,464	1,757	2,100	700	2,430	2,800	1,996	5,230	3,729
6	19,700	-	179	836	-	836	564	1,867	1,244	2,364	788	2,736	3,152	2,100	5,888	3,923
7-30	19,700	-	179	-	-	-	564	743	5,678	2,364	788	2,736	3,152	24,088	5,888	44,996
PRESENT VALUE*									22,463(C)					31,264(B)		58,402(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	1.39	2.60
Net Present Value = B-C =	$8.8M	$35.9M

Table C-10

ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - SITE 7B-1 PLUS SITE LB1 PLUS SITE SC2 (300 cfs)
($ 000 1985

Year	Area (acres)	INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
		Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	11,500	-	-	-	-	-	11,500	10,748	-	-	-	-	-	-	-
2	-	17,250	-	-	-	-	-	17,250	15,066	-	-	-	-	-	-	-
3	10,500	-	575	534	-	3,990	285	5,384	4,395	1,260	420	1,458	1,680	1,371	3,138	2,562
4	14,000	-	575	306	-	1,330	388	2,599	1,983	1,680	560	1,944	2,240	1,709	4,184	3,192
5	17,500	-	575	459	-	1,330	496	2,860	2,039	2,100	700	2,430	2,800	1,996	5,230	3,729
6	21,000	-	575	520	-	1,330	614	3,039	2,025	2,520	840	2,916	3,360	2,239	6,276	4,182
7	24,500	-	575	700	-	1,330	757	3,362	2,094	2,940	980	3,403	3,920	2,441	7,323	4,560
8	28,000	-	575	700	-	1,330	901	3,506	2,040	3,360	1,120	3,889	4,480	2,607	8,369	4,871
9	31,500	-	575	839	-	1,330	1,046	3,790	2,061	3,780	1,260	4,375	5,040	2,741	9,415	5,121
10	35,000	-	575	1,050	-	1,330	1,193	4,148	2,108	4,200	1,400	4,861	5,600	2,846	10,461	5,317
11	38,500	-	575	1,050	-	1,330	1,340	4,295	2,041	4,620	1,540	5,347	6,160	2,927	11,507	5,467
12	42,000	-	575	1,050	-	1,330	1,487	4,442	1,972	5,040	1,680	5,833	6,720	2,984	12,553	5,574
13	45,200	-	575	960	-	1,216	1,622	4,373	1,815	5,424	1,808	6,277	7,232	3,001	13,509	5,606
14-30	45,200	-	575	-		-	1,622	2,197	8,900	5,424	1,808	6,277	7,232	29,297	13,509	54,725
PRESENT VALUE*									59,287(C)					56,159(B)		104,906(B')

*Real discount rate = 7% per annum.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	0.95	1.77
Net Present Value = B-C =	($3.1M)	$45.6M

APPENDIX D

AGRICULTURAL CENSUS PROFILE

APPENDIX D

AGRICULTURAL PROFILE, 1980-81*
County #2 - Vulcan

Number of farms	824
Farm population	2,577
Average Acre/Farm	1,383 acres

Crops	49%
Pasture	5%
Summerfallow	29%
Other Improved	1%
Unimproved	16%

Crops:

Spring Wheat	47%	Rye	7%
Durum Wheat	10	Flax	2
Utility Wheat	2	Canola	3
Winter Wheat	2	Mustard	-
Oats	2	Hay	4
Barley	19	Oat/Other Fodder	1
		Other	-

Livestock Numbers:

Cattle and calves	47,780
Cattle on feed	7,355
Hogs	16,649
Poultry (chicken)	69,115

Farm Types:

Dairy	1%	Wheat	47%
Cattle	11	Small Grains	35
Hogs	1	Other Crops	-
Poultry	-	Mixed	4
		Miscellaneous	1

Farm Revenue: (#)

<$10,000	65
$10 - $50,000	295
$50 - $100,000	266
$100 - $250,000	165
>$250,000	33
Average	$79,515

Hired Labor:	
Number of farms	41%
Average for all farms	11.5 weeks/year
Average Farm Capital:	
Total	$1,091,749
Land and Buildings	937,605**
Machinery	119,927
Livestock	34,217

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*Includes both dryland and irrigation. Errors due to rounding.

**Land value 90% of the total value.

Source: Statistics Canada, *Census of Agriculture, Alberta, 1981*, Ottawa, 1982.

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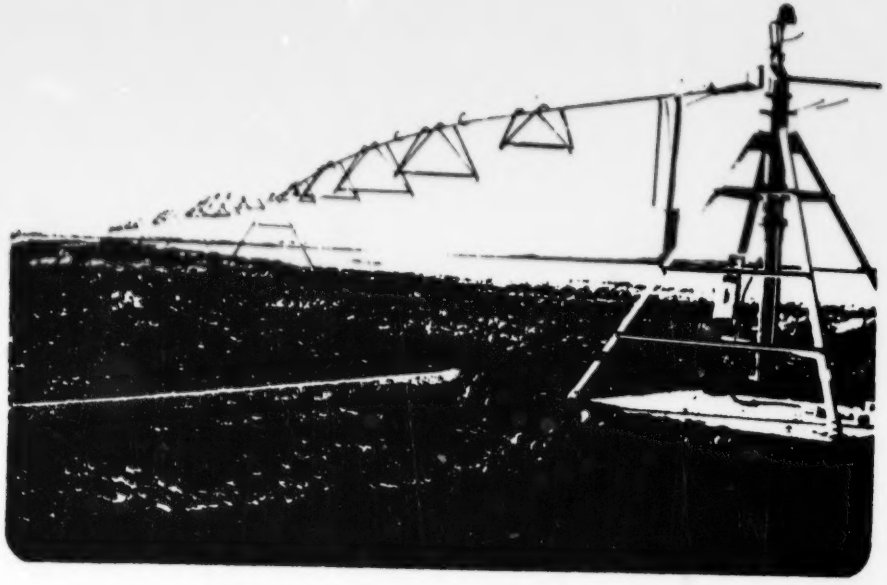
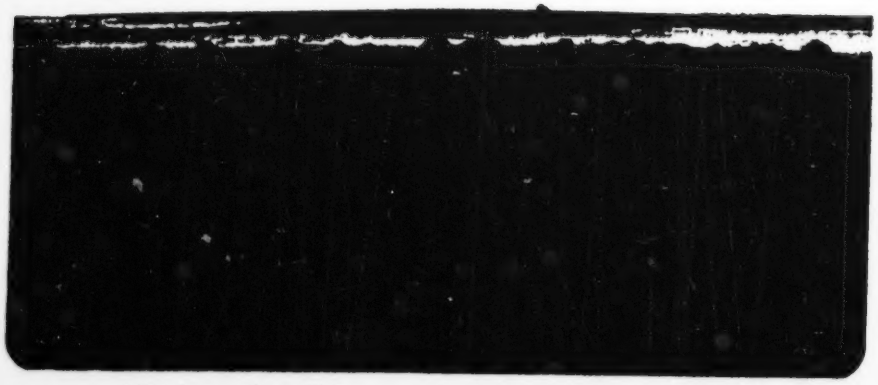
Existing electric pumping unit on the Little Bow River



On-going installation of a center pivot



Wind-eroded "blow out" on existing dryland

Little Bow River near the proposed 7B-1 dam site